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English
Rev. DA

Model 8800C and Model 8800A Vortex Flowmeter with FOUNDATION™ Fieldbus

(Device Revision 2)

PlantWeb

FOUNDATION

ROSEMOUNT®

FISHER-ROSEMOUNT™ Managing The Process Better.™

Product Manual

Model 8800C and Model 8800A Vortex Flowmeter with FOUNDATION™ Fieldbus

(Device Revision 2)

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

Within the United States, Rosemount Inc. has two toll-free assistance numbers.

Customer Central: 1-800-999-9307 (*7:00 a.m. to 7:00 p.m. CST)*
Technical support, quoting, and order-related questions.

North American Response Center: 1-800-654-7768 (*24 hours a day – Includes Canada)*
Equipment service needs.

For equipment service or support needs outside the United States, contact your local Rosemount representative.

⚠CAUTION

The products described in this document are NOT designed for nuclear-qualified applications.

Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Rosemount Sales Representative.

SNF-0004

Fisher-Rosemount Flow
Groeneveldselaan 6-8
3903 AZ Veenendaal
The Netherlands
Tel 31 (0) 318 549 549
Fax 31 (0) 318 549 559
Tel 0800-966 180 (U.K. only)
Fax 0800-966 181 (U.K. only)

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA
Tel 1-800-999-9307
Fax (612) 949-7001

http://www.rosemount.com

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CE Fisher-Rosemount satisfies all obligations coming from legislation to harmonize product requirements in the European Union.

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IMPORTANT

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. **Refer to the safety messages at the beginning of each section before performing any operations.**

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Section 1

Introduction

HOW TO USE THIS MANUAL

This manual provides installation, configuration, troubleshooting, and other procedures for the Rosemount Model 8800C Vortex Flowmeter with FOUNDATION fieldbus. Specifications and other important information are also included.

Section 2: Installation
Section 2 provides assistance in hardware configuration.

Section 3: Flowmeter Operation
Section 3 describes the Model 8800C Flowmeter software functions, configuration parameters, and other online variables. The descriptions are provided according to the function you want to perform.

Section 4: Transducer Block
Section 4 describes the transducer block and its operation.

Section 5: Resource Block
Section 5 describes the resource block and its operation.

Section 6: Maintenance and Troubleshooting
Section 6 supplies troubleshooting tables to lead you through any problems that may arise in the use of the Model 8800C Flowmeter. Section 6 also describes corrective actions that should be taken.

Section 7: Options
Section 7 lists the options available to customers for the Model 8800C Flowmeter.

Section 8: Specifications
Section 8 gives reference and specification data for the Model 8800C Flowmeter and its applications.

Section 9: Electronics Verification
Section 9 provides a short procedure for verification of electronic output to assist in meeting the quality standards for ISO 9000 certified manufacturing processes.

Appendix A: FOUNDATION™ Fieldbus Technology and Fieldbus Function Blocks
Appendix A describes the basic information about fieldbus and the function blocks that are common to all fieldbus devices.

Appendix B: Analog Input (AI) Function Block
Appendix B describes the operation and parameters of the AI function block.

Appendix C: PID Function Block
Appendix C describes the operation and parameters of the Proportional/Integral/Derivative (PID) function block.

Appendix D: Operation with Fisher-Rosemount® DeltaV™

Appendix D provides specific instructions for performing basic configuration operations on the Rosemount Model 8800C Flowmeter using the Fisher-Rosemount DeltaV host software.

SAFETY MESSAGES

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Refer to the safety messages, listed at the beginning of each section, before performing any operations.

FOUNDATION Fieldbus Technology

FOUNDATION fieldbus is an all digital, serial, two-way communication system that interconnects field equipment such as sensors, actuators, and controllers. Fieldbus is a Local Area Network (LAN) for instruments used in both process and manufacturing automation with built-in capability to distribute the control application across the network. The fieldbus environment is the base level group of digital networks in the hierarchy of plant networks.

The fieldbus retains the desirable features of the 4–20 mA analog system, including a standardized physical interface to the wire, bus-powered devices on a single pair of wires, and intrinsic safety options, and enables additional capabilities, such as:

- Increased capabilities due to full digital communications
- Reduced wiring and wire terminations due to multiple devices on one pair of wires
- Increased selection of suppliers due to interoperability
- Reduced loading on control room equipment with the distribution of some control and input/output functions to field devices
- Speed options for process control and manufacturing applications

Section 2 Installation

Section 2 provides specific information pertaining to the installation of the Model 8800C Vortex Flowmeter with FOUNDATION fieldbus.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please refer to the following safety messages before performing any operation in this section.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

GENERAL CONSIDERATIONS

Before you install a flowmeter in any application, you must consider flowmeter sizing (the line size) and location. Choose the correct flowmeter size for an application to increase rangeability and minimize pressure drop and cavitation. Proper location of the flowmeter can ensure a clean, accurate signal. Follow the installation instructions carefully to reduce start-up delays, ease maintenance, and ensure optimum performance.

Flowmeter Sizing

Correct meter sizing is important for flowmeter performance. The Model 8800C Flowmeter is capable of processing signals from flow applications within the limitations described in Section 8: Specifications. Full scale is continuously adjustable within these ranges.

To determine the correct flowmeter size for an application, process conditions must be within the stated requirements for Reynolds number and velocity. See Section 8: Specifications for sizing data.

Contact your local Rosemount Inc. sales representative to obtain a copy of the Model 8800C Vortex Flowmeter Sizing Program, which calculates flowmeter sizes based on user-supplied input.

Flowmeter Orientation

Design process piping so the meter body will remain full, with no entrapped air. Allow enough straight pipe both upstream and downstream of the meter body to ensure a nonskewed, symmetrical profile. Install valves downstream of the meter when possible.

Vertical Installation

Vertical installation allows upward process liquid flow and is generally preferred. Upward flow ensures that the meter body always remains full and that any solids in the fluid are evenly distributed.

The vortex meter can be mounted in the vertical down position when measuring gas or steam flows. This type of application should be strongly discouraged for liquid flows, although it can be done with proper piping design.

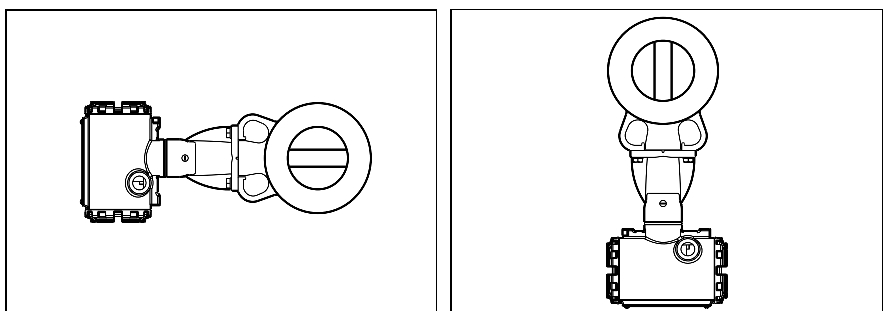
NOTE
To ensure that the meter body remains full, avoid downward vertical liquid flows where back pressure is inadequate.

High-Temperature Installations

Install the meter body so the electronics are positioned to the side of the pipe or below the pipe, as shown in Figure 2-1. Insulation may be required around the pipe to maintain a temperature below 185 °F (85 °C).

When insulating, the insulation should be made only around the pipe and meter body. Leave part of the support tube bracket exposed to ambient environment for both remote and integral installations. This aids in dissipating the heat from the process.

Figure 2-1.
Examples of High-Temperature Installations.



The meter body installed with the electronics to the side of the pipe.

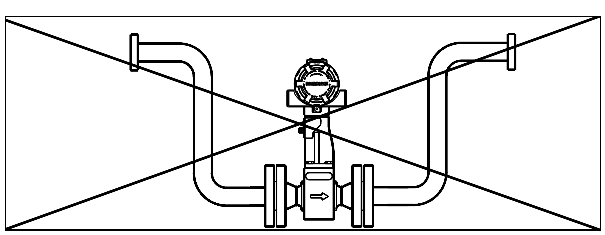
The meter body installed with the electronics below the pipe.

8800-0002A01C

Steam Installations

For steam applications, avoid installations such as the one shown in Figure 2-2. Such installations may cause a water-hammer condition at start-up due to trapped condensate. The high force from the water hammer can overstress the sensing mechanism and cause permanent damage to the sensor.

Figure 2-2.
Avoid This Type of Installation for Steam Applications.



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Upstream/Downstream Piping

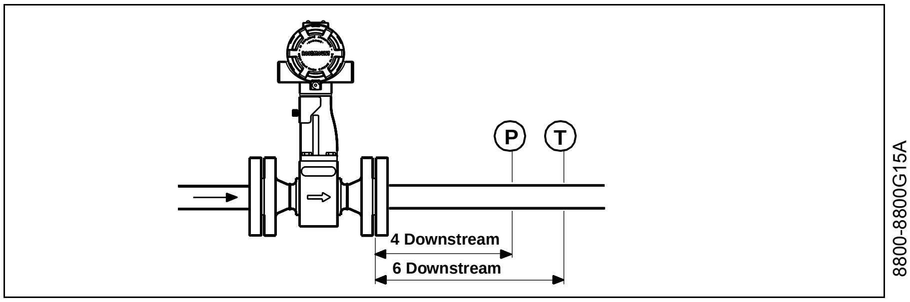
The vortex meter may be installed with a minimum of ten straight pipe diameters (D) upstream and five straight pipe diameters (D) downstream.

Rated accuracy is based on the number of pipe diameters from an upstream disturbance. An additional 0.5% shift in K-factor may be introduced between 10 D and 35 D, depending on disturbance. For more information on installation effects, see Technical Data Sheet 00816-0100-3250.

Pressure and Temperature Transmitter Location

When using pressure and temperature transmitters in conjunction with the Model 8800C Flowmeter for compensated mass flows, install the transmitter downstream of the Vortex Flowmeter. See Figure 2-3.

Figure 2-3.
Pressure and Temperature Transmitter Location.



Wetted Material Selection

Ensure that the process fluid is compatible with the meter body wetted materials when specifying the Model 8800C Flowmeter. Corrosion will shorten the life of the meter body. Consult recognized sources of corrosion data or contact your Rosemount sales representative for more information.

Environmental Considerations

Avoid excessive heat and vibration to ensure maximum flowmeter life. Typical problem areas include high-vibration lines with integrally mounted electronics, warm-climate installations in direct sunlight, and outdoor installations in cold climates.

Although the signal-conditioning functions reduce susceptibility to extraneous noise, some environments are more suitable than others. Avoid placing the flowmeter or its wiring close to devices that produce high intensity electromagnetic and electrostatic fields. Such devices include electric welding equipment, large electric motors and transformers, and communication transmitters.

HAZARDOUS LOCATIONS

The Model 8800C has an explosion-proof housing and circuitry suitable for intrinsically safe and non-incendive operation. Individual transmitters are clearly marked with a tag indicating the certifications they carry. To maintain certified ratings for installed transmitters, install in accordance with all applicable installation codes and approval drawings. See Section 8: Specifications for specific approval categories and Appendix E: Approval Drawings.

IMPORTANT
Once a device labeled with multiple approval types is installed, it should not be reinstalled using any of the other labeled approval types. To ensure this, the approval label should be permanently marked to distinguish the used form from the unused approval type(s).

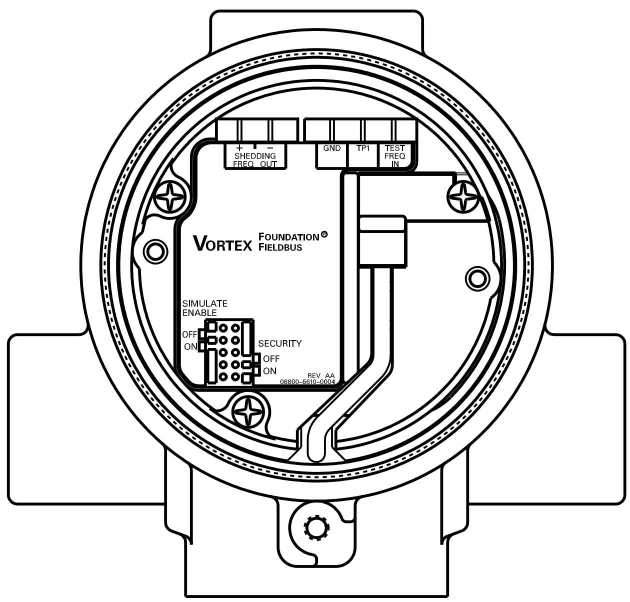
Hardware Configuration

The hardware jumpers on the Model 8800C Flowmeter enable you to set the fieldbus simulate enable and transmitter security (see Figure 2-4). To access the jumpers, remove the electronics housing cover from the end of the Model 8800C Flowmeter. If your Model 8800C Flowmeter does not include an LCD indicator, the jumpers are accessible by removing the cover on the electronics side. If your Model 8800C Flowmeter includes an LCD option, the fieldbus simulate enable and security jumpers are found on the face of the LCD indicator (see Figure 2-5).

NOTE
If you will be changing configuration variables frequently, leave the security lockout jumper in the OFF position to avoid exposing the flowmeter electronics to the plant environment.

Set jumpers during the commissioning stage to avoid exposing the electronics to the plant environment.

Figure 2-4.
Fieldbus Simulate Enable and Transmitter Security Jumpers.



Simulate Enable

The simulate enable jumper is used in conjunction with the Analog Input (AI) function block simulation. The jumper is also used as a lock-out feature for the AI function block. To enable the simulate enable feature, the jumper must transition from OFF to ON *after* power is applied to the transmitter, preventing the transmitter from being accidentally left in simulator mode.

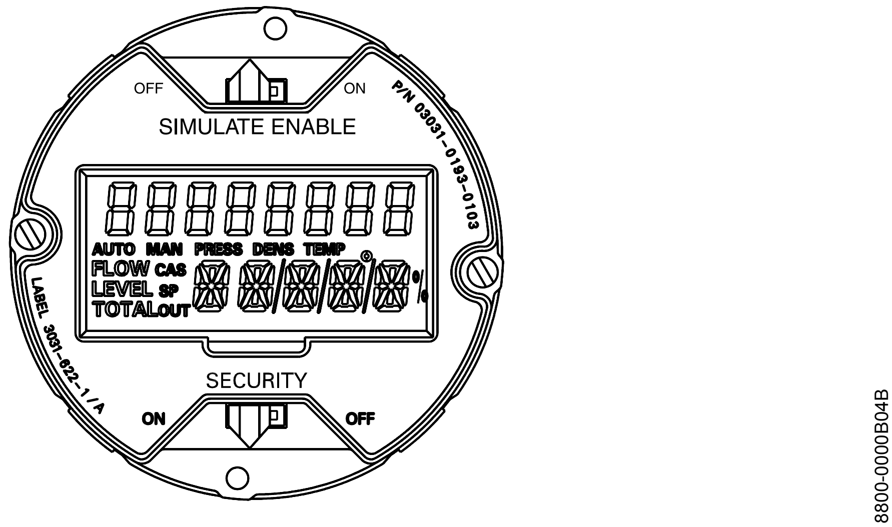
Transmitter Security

After you configure the transmitter, you may want to protect the configuration data from unwarranted changes. Each transmitter is equipped with a security jumper that can be positioned ON to prevent the accidental or deliberate change of configuration data. The jumper is located on the front side of the electronics module and is labeled SECURITY (see Figure 2-4).

LCD Indicator Option

If your electronics are equipped with the LCD indicator (Option M5), the fieldbus simulate enable and transmitter security jumpers are located on the face of the indicator as shown in Figure 2-5.

Figure 2-5. LCD Indicator Fieldbus Simulate Enable and Transmitter Security Jumpers.



INSTALLATION TASKS

The installation tasks include detailed mechanical and electrical installation procedures.

Handling

Handle all parts carefully to prevent damage. Whenever possible, transport the system to the installation site in the original shipping containers. Keep the shipping plugs in the conduit connections until you are ready to connect and seal them.

Flow Direction

Mount the meter body so the FORWARD end of the flow arrow, shown on the meter body, points in the direction of the flow through the body.

Gaskets

The Model 8800C Flowmeter requires gaskets supplied by the user. Be sure to select gasket material that is compatible with the process fluid and pressure ratings of the specific installation.

NOTE
Ensure that the inside diameter of the gasket is larger than the inside diameter of the flowmeter and adjacent piping. If gasket material extends into the flow stream, it will disturb the flow and cause inaccurate measurements.

Flange Bolts

Install the Model 8800C Flowmeter between two conventional pipe flanges, as shown in Figure 2-6 and Figure 2-7 on page 2-8. Table 2-1, Table 2-2, and Table 2-3 list the recommended minimum stud bolt lengths for wafer-style meter body size and different flange ratings.

TABLE 2-1. Minimum Recommended Stud Bolt Lengths for Wafer Installation with ANSI Flanges.

Line Size	Minimum Recommended Stud Bolt Lengths (in Inches) for Each Flange Rating		
	Class 150	Class 300	Class 600
½ in.	6.00	6.25	6.25
1 in.	6.25	7.00	7.50
1½ in.	7.25	8.50	9.00
2 in.	8.50	8.75	9.50
3 in.	9.00	10.00	10.50
4 in.	9.50	10.75	12.25
6 in.	10.75	11.50	14.00
8 in.	12.75	14.50	16.75

TABLE 2-2. Minimum Recommended Stud Bolt Lengths for Wafer Installation with DIN Flanges.

Line Size	Minimum Recommended Stud Bolt Lengths (in mm) for Each Flange Rating			
	PN 16	PN 40	PN 64	PN 100
DN 15	160	160	170	170
DN 25	160	160	200	200
DN 40	200	200	230	230
DN 50	220	220	250	270
DN 80	230	230	260	280
DN 100	240	260	290	310
DN 150	270	300	330	350
DN 200	320	360	400	420

TABLE 2-3.
Minimum Recommended Stud Bolt Lengths for Wafer Installation with JIS Flanges.

Line Size	Minimum Recommended Stud Bolt Lengths (in mm) for Each Flange Rating		
	JIS 10k	JIS 16k and 20k	JIS 40k
15 mm	150	155	185
25 mm	175	175	190
40 mm	195	195	225
50 mm	210	215	230
80 mm	220	245	265
100 mm	235	260	295
150 mm	270	290	355
200 mm	310	335	410

Wafer-Style Flowmeter Alignment and Mounting

Center the wafer-style meter body inside diameter with respect to the inside diameter of the adjoining upstream and downstream piping, which will ensure that the flowmeter achieves its specified accuracy.

Alignment rings are provided with each wafer-style meter body for centering purposes. Complete the following steps to align the meter body for installation. Refer to Figure 2-6 on page 2-8.

1. Place the alignment rings over each end of the meter body.
2. Insert the studs for the bottom side of the meter body between the pipe flanges.
3. Place the meter body (with alignment rings) between the flanges. Make sure that the alignment rings are properly placed onto the studs. Align the studs with the markings on the ring that correspond to the flange you are using.

NOTE
Align the flowmeter so the electronics are accessible, the conduits drain, and the flowmeter is not subject to direct heat.

4. Place the remaining studs between the pipe flanges.
5. Tighten the nuts in the sequence shown in Figure 2-8 on page 2-9.
6. Check for leaks at the flanges after tightening the flange bolts.

NOTES
The required bolt load for sealing the gasket joint is affected by several factors, including operating pressure and gasket material, width, and condition. A number of factors also affect the actual bolt load resulting from a measured torque, including condition of bolt threads, friction between the nut head and the flange, and parallelism of the flanges. Due to these application-dependent factors, the required torque for each application may be different. Follow the guidelines outlined in the ASME Pressure Vessel Code (Section VIII, Division 2) for proper bolt tightening.

Make sure the flowmeter is centered between flanges of the same nominal size as the flowmeter.

Spacers

Spacers are available with the Model 8800C to maintain the Model 8800A dimensions. If a spacer is used, it should be downstream of the meter body. The spacer kit comes with an alignment ring for ease of installation. Gaskets should be placed on each side of the spacer.

TABLE 2-4. Dimensions for Spacers.

Line Size	Dimensions inch (mm)
1.5 (40)	0.47 (11.9)
2 (50)	1.17 (29.7)
3 (80)	1.27 (32.3)
4 (100)	0.97 (24.6)

FIGURE 2-6.
Wafer-Style Flowmeter Installation with Alignment Rings.

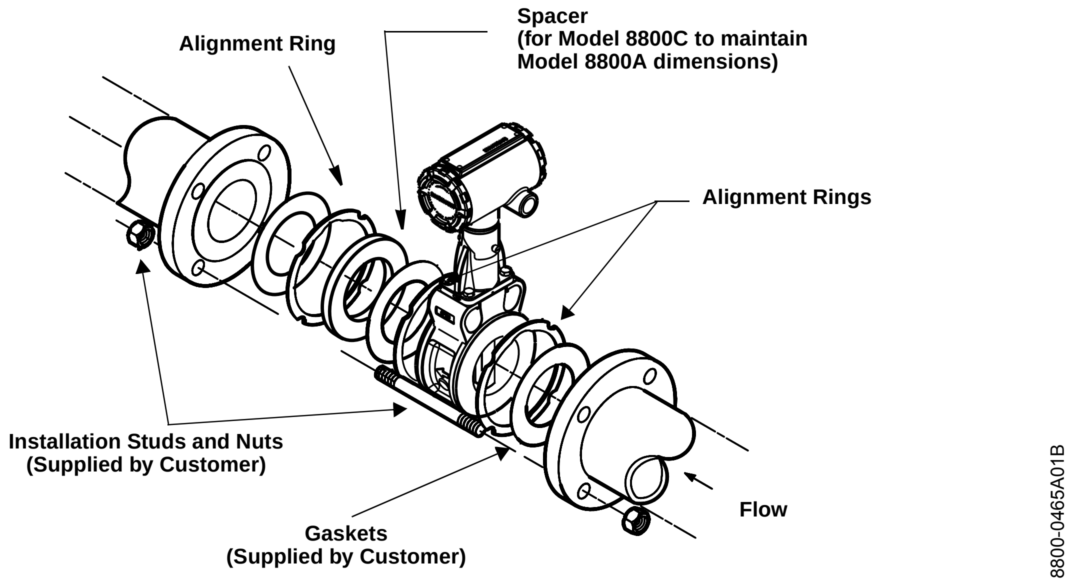
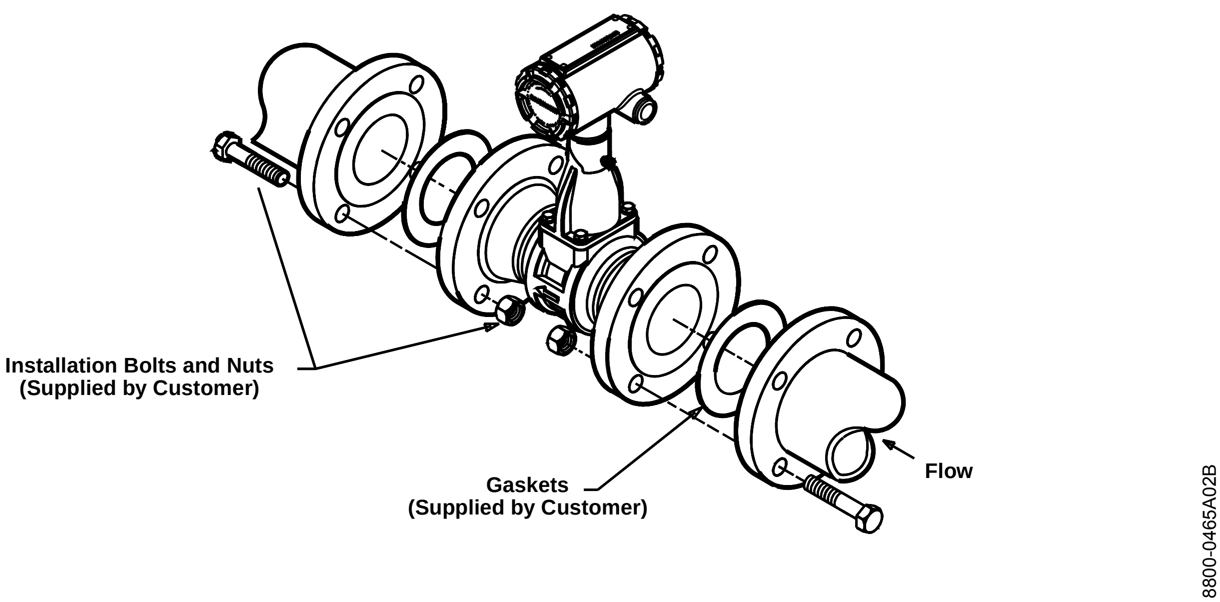


FIGURE 2-7.
Flanged-Style Flowmeter Installation.



Flanged-Style Flowmeter Mounting

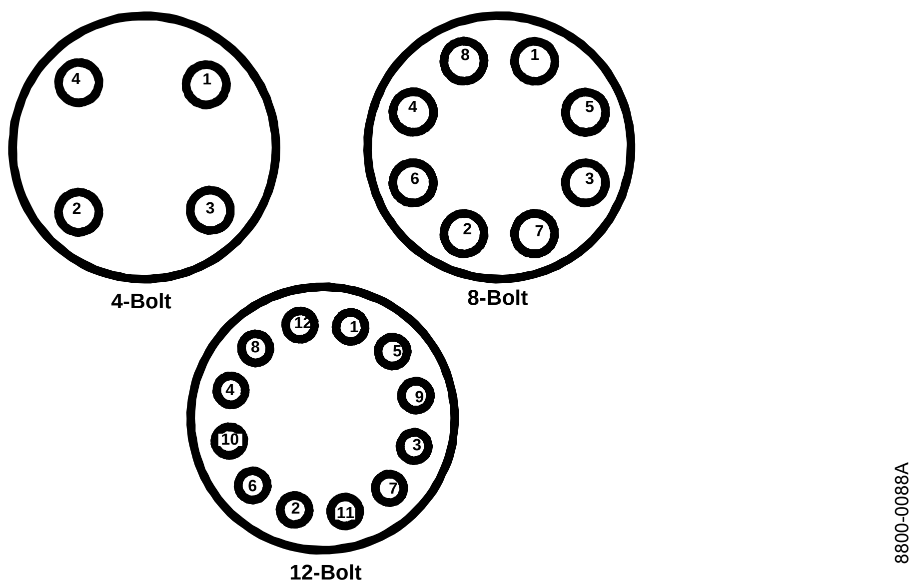
Mounting a flanged-style flowmeter is similar to installing a typical section of pipe. Conventional tools, equipment, and accessories (such as bolts and gaskets) are required. Tighten the nuts following the sequence shown in Figure 2-8.

NOTES

The required bolt load for sealing the gasket joint is affected by several factors, including operating pressure and gasket material, width, and condition. A number of factors also affect the actual bolt load resulting from a measured torque, including condition of bolt threads, friction between the nut head and the flange, and parallelism of the flanges. Due to these application-dependent factors, the required torque for each application may be different. Follow the guidelines outlined in the ASME Pressure Vessel Code (Section VIII, Division 2) for proper bolt tightening.

Make sure the flowmeter is centered between flanges of the same nominal size as the flowmeter.

Figure 2-8. Flange Bolt Torquing Sequence.



Flowmeter Grounding

Grounding is not required in typical vortex applications; however, a good ground will eliminate possible noise pickup by the electronics. Grounding straps may be used to ensure that the meter is grounded to the process piping.

To use grounding straps, secure one end of the grounding strap to the bolt extending from the side of the meter body and attach the other end of each grounding strap to a suitable ground.

Electronics Considerations

Integral and remote-mounted electronics require input power at the electronics. For remote-mount installations, mount the electronics against a flat surface or on a pipe that is up to two inches in diameter. Pipe and surface-mounting hardware is included with remote-mount electronics. See Figure 2-16 on page 2-18 for dimensional information.

High-Temperature Installations

Install the meter body so the electronics are positioned to the side of or below the pipe, as shown in Figure 2-1 on page 2-2. Insulation may be required around the pipe to maintain a temperature below 185 °F (85 °C).

Conduit Connections

The electronics housing has two ports for ½–14 NPT conduit connections. Adapters are also available for PG 13.5 or M20×1.5 conduit. These connections are made in a conventional manner in accordance with local or plant electrical codes. Be sure to properly seal unused ports to prevent moisture or other contamination from entering the terminal block compartment of the electronics housing.

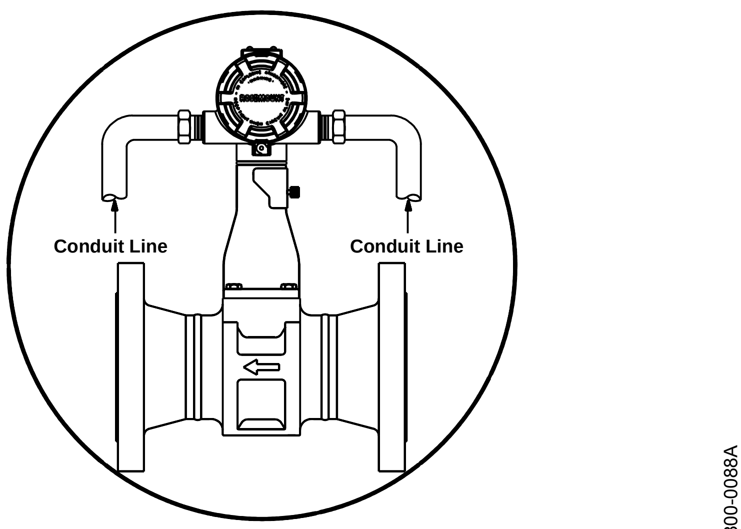
NOTE
In some applications it may be necessary to install conduit seals and arrange for conduits to drain to prevent moisture from entering the wiring compartment.

High-Point Installation

Prevent condensation in any conduit from flowing into the housing by mounting the flowmeter at a high point in the conduit run. If the flowmeter is mounted at a low point in the conduit run, the terminal compartment could fill with fluid.

If the conduit originates above the flowmeter, route conduit below the flowmeter before entry. In some cases a drain seal may need to be installed.

Figure 2-9. Proper Conduit Installation with the Model 8800C Flowmeter.



Cable Gland

If you are using cable gland instead of conduit, follow the cable gland manufacturer's instructions for preparation and make the connections in a conventional manner in accordance with local or plant electrical codes. Be sure to properly seal unused ports to prevent moisture or other contamination from entering the terminal block compartment of the electronics housing.

Figure 2-10. Flanged-Style Flowmeter Dimensional Drawings (1/2- through 8-in. / 15 through 200 mm Line Sizes).

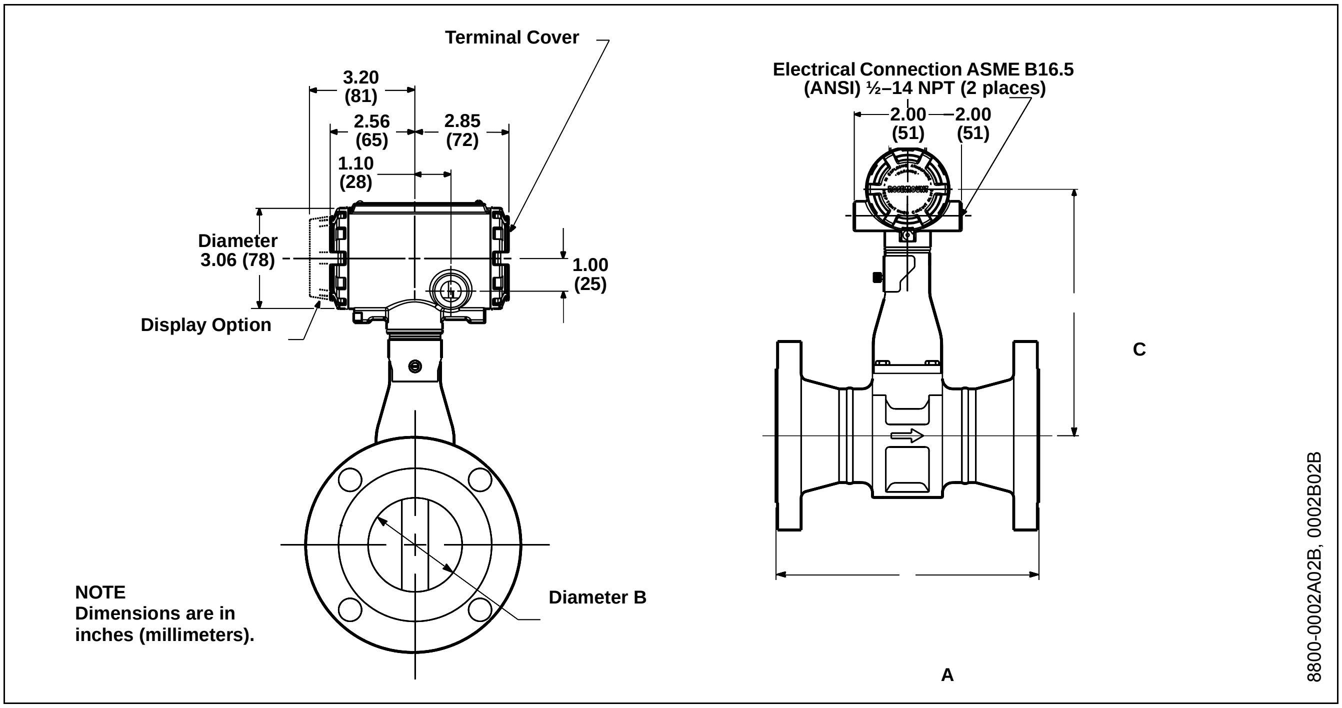


TABLE 2-5. Flanged-Style Flowmeter (1/2- through 2-in. / 15 through 50 mm Line Sizes).

Nominal Size Inch (mm)	Flange Rating	Face-to-face A Inch (mm)	A ANSI RTJ Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Weight(1) lb (kg)
½ (15)	Class 150	6.87 (174.5)	–	0.54 (13.7)	7.63 (194)	9.3 (4.2)
	Class 300	7.23 (183.6)	7.66 (194.7)	0.54 (13.7)	7.63 (194)	10.8 (4.9)
	Class 600	7.73 (196.3)	7.66 (194.7)	0.54 (13.7)	7.63 (194)	10.8 (4.9)
	PN 16/40	6.11 (155.2)	–	0.54 (13.7)	7.63 (194)	9.5 (4.3)
	PN 100	6.65 (168.9)	–	0.54 (13.7)	7.63 (194)	11.0 (5.0)
	JIS 10K/20K	6.3 (160)	–	0.54 (13.7)	7.63 (194)	10.1 (4.5)
	JIS 40K	7.3 (185)	–	0.54 (13.7)	7.63 (194)	13.5 (6.1)
1 (25)	Class 150	7.51 (190.8)	8.01 (203.5)	0.95 (24.1)	7.74 (197)	15.5 (7.0)
	Class 300	8.01 (203.5)	8.51 (216.2)	0.95 (24.1)	7.74 (197)	18.5 (8.4)
	Class 600	8.51 (216.2)	8.51 (216.2)	0.95 (24.1)	7.74 (197)	19.0 (8.6)
	PN 16/40	6.27 (159.3)	–	0.95 (24.1)	7.74 (197)	13.9 (6.3)
	PN 100	7.69 (195.3)	–	0.95 (24.1)	7.74 (197)	22.5 (10.2)
	JIS 10K/20K	6.5 (165)	–	0.95 (24.1)	7.74 (197)	13.7 (6.2)
	JIS 40K	7.9 (200)	–	0.95 (24.1)	7.74 (197)	17.4 (7.9)
1 ½ (40)	Class 150	8.24 (209.3)	8.74 (222.0)	1.49 (37.8)	8.14 (207)	20.8 (9.5)
	Class 300	8.74 (222.0)	9.24 (234.8)	1.49 (37.8)	8.14 (207)	26.3 (11.9)
	Class 600	9.36 (237.7)	9.36 (237.8)	1.49 (37.8)	8.14 (207)	29.3 (13.3)
	PN 16/40	6.90 (175.3)	–	1.49 (37.8)	8.14 (207)	22.8 (10.3)
	PN 100	8.24 (209.3)	–	1.49 (37.8)	8.14 (207)	30.7 (13.9)
	JIS 10K/20K	7.3 (185)	–	1.49 (37.8)	8.14 (207)	18.6 (8.4)
	JIS 40K	8.5 (215)	–	1.49 (37.8)	8.14 (207)	25.6 (11.6)
2 (50)	Class 150	9.26 (235.2)	9.76 (248.0)	1.92 (48.8)	8.49 (216)	23.0 (10.4)
	Class 300	9.76 (247.9)	10.39 (263.9)	1.92 (48.8)	8.49 (216)	27.0 (12.3)
	Class 600	10.52 (267.2)	10.65 (270.5)	1.92 (48.8)	8.49 (216)	31.5 (14.3)
	PN 16/40	8.04 (204.2)	–	1.92 (48.8)	8.49 (216)	23.7 (10.8)
	PN 64	9.15 (232.3)	–	1.92 (48.8)	8.49 (216)	31.3 (14.2)
	PN 100	9.62 (244.3)	–	1.92 (48.8)	8.49 (216)	38.0 (17.2)
	JIS 10K	7.7 (195)	–	1.92 (48.8)	8.49 (216)	19.5 (8.8)
	JIS 20K	8.3 (210)	–	1.92 (48.8)	8.49 (216)	20.1 (9.1)
	JIS 40K	9.8 (250)	–	1.92 (48.8)	8.49 (216)	28.3 (12.8)

(1) Add 0.2 lb (0.1 kg) for display option.

TABLE 2-6. Flanged-Style Flowmeter (3- through 8-in. / 80 through 200 mm Line Sizes).(1)

Nominal Size Inch (mm)	Flange Rating	Face-to-face A Inch (mm)	A ANSI RTJ Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Weight(2) lb (kg)
3 (80)	Class 150	9.87 (250.7)	10.38 (263.5)	2.87 (72.9)	9.05 (230)	41.5 (18.8)
	Class 300	10.61 (269.5)	11.24 (285.5)	2.87 (72.9)	9.05 (230)	49.5 (22.4)
	Class 600	11.37 (288.8)	11.50 (292.1)	2.87 (72.9)	9.05 (230)	55.0 (24.9)
	PN 16/40	8.93 (226.8)	–	2.87 (72.9)	9.05 (230)	37.9 (17.2)
	PN 64	10.04 (259.9)	–	2.87 (72.9)	9.05 (230)	46.5 (21.1)
	PN 100	10.51 (266.9)	–	2.87 (72.9)	9.05 (230)	56.9 (25.8)
	JIS 10K	7.9 (200)	–	2.87 (72.9)	9.05 (230)	27.6 (12.5)
	JIS 20K	9.3 (235)	–	2.87 (72.9)	9.05 (230)	35.0 (15.9)
	JIS 40K	11.0 (280)	–	2.87 (72.9)	9.05 (230)	50.0 (22.7)
4 (100)	Class 150	10.24 (260.1)	10.76 (273.3)	3.79 (96.3)	9.60 (244)	55.5 (25.2)
	Class 300	11.00 (279.4)	11.64 (295.8)	3.79 (96.3)	9.60 (244)	74.0 (33.5)
	Class 600	12.74 (323.6)	12.88 (327.2)	3.79 (96.3)	9.60 (244)	101.0 (45.8)
	PN 16	8.34 (211.8)	–	3.79 (96.3)	9.60 (244)	41.3 (18.7)
	PN 40	9.36 (237.7)	–	3.79 (96.3)	9.60 (244)	49.9 (22.6)
	PN 64	10.40 (264.2)	–	3.79 (96.3)	9.60 (244)	63.7 (28.9)
	PN 100	11.32 (287.5)	–	3.79 (96.3)	9.60 (244)	82.3 (37.3)
	JIS 10K	8.7 (220)	–	3.79 (96.3)	9.60 (244)	37.0 (16.8)
	JIS 20K	8.7 (220)	–	3.79 (96.3)	9.60 (244)	44.9 (20.4)
	JIS 40K	11.8 (300)	–	3.79 (96.3)	9.60 (244)	75.3 (34.2)
6 (150)	Class 150	11.59 (294.4)	12.09 (307.1)	5.70 (144.8)	10.79 (274)	89.0 (403)
	Class 300	12.35 (313.7)	12.97 (329.5)	5.70 (144.8)	10.79 (274)	129.0 (58.5)
	Class 600	14.33 (364.0)	14.45 (367.1)	5.70 (144.8)	10.79 (274)	187.0 (84.8)
	PN 16	8.93 (226.8)	–	5.70 (144.8)	10.79 (274)	73.9 (33.5)
	PN 40	10.49 (266.5)	–	5.70 (144.8)	10.79 (274)	92.2 (41.8)
	PN 64	12.07 (306.6)	–	5.70 (144.8)	10.79 (274)	136.7 (62.0)
	PN 100	13.65 (346.7)	–	5.70 (144.8)	10.79 (274)	175.2 (79.5)
	JIS 10K	10.6 (270)	–	5.70 (144.8)	10.79 (274)	79.8 (36.2)
	JIS 20K	10.6 (270)	–	5.70 (144.8)	10.79 (274)	97.7 (44.3)
	JIS 40K	14.2 (360)	–	5.70 (144.8)	10.79 (274)	175.9 (79.8)
8 (200)	Class 150	13.58 (344.9)	14.08 (357.6)	7.55 (191.8)	11.71 (298)	141.0 (63.9)
	Class 300	14.34 (364.2)	14.96 (380.1)	7.55 (191.8)	11.71 (298)	195.0 (88.4)
	Class 600	16.58 (421.1)	16.70 (424.3)	7.55 (191.8)	11.71 (298)	279.0 (126.5)
	PN 10	10.46 (265.7)	–	7.55 (191.8)	11.71 (298)	108.0 (49)
	PN 16	10.46 (265.7)	–	7.55 (191.8)	11.71 (298)	106.6 (48.4)
	PN 25	11.88 (301.8)	–	7.55 (191.8)	11.71 (298)	133.2 (60.4)
	PN 40	12.50 (317.5)	–	7.55 (191.8)	11.71 (298)	153.9 (69.8)
	PN 64	14.24 (361.7)	–	7.55 (191.8)	11.71 (298)	213.0 (96.6)
	PN 100	15.82 (401.8)	–	7.55 (191.8)	11.71 (298)	295.0 (133.8)
	JIS 10K	12.2 (310)	–	7.55 (191.8)	11.71 (298)	109.9 (49.9)
	JIS 20K	12.2 (310)	–	7.55 (191.8)	11.71 (298)	134.3 (60.9)
	JIS 40K	16.5 (420)	–	7.55 (191.8)	11.71 (298)	255.7 (116.0)

(1) Refer to Figure 2-10.
(2) Add 0.2 lb (0.1 kg) for display option.

Figure 2-11. Wafer-Style Dimensional Drawings (1/2- through 1 1/2-in. / 15 through 40 mm Line Sizes).

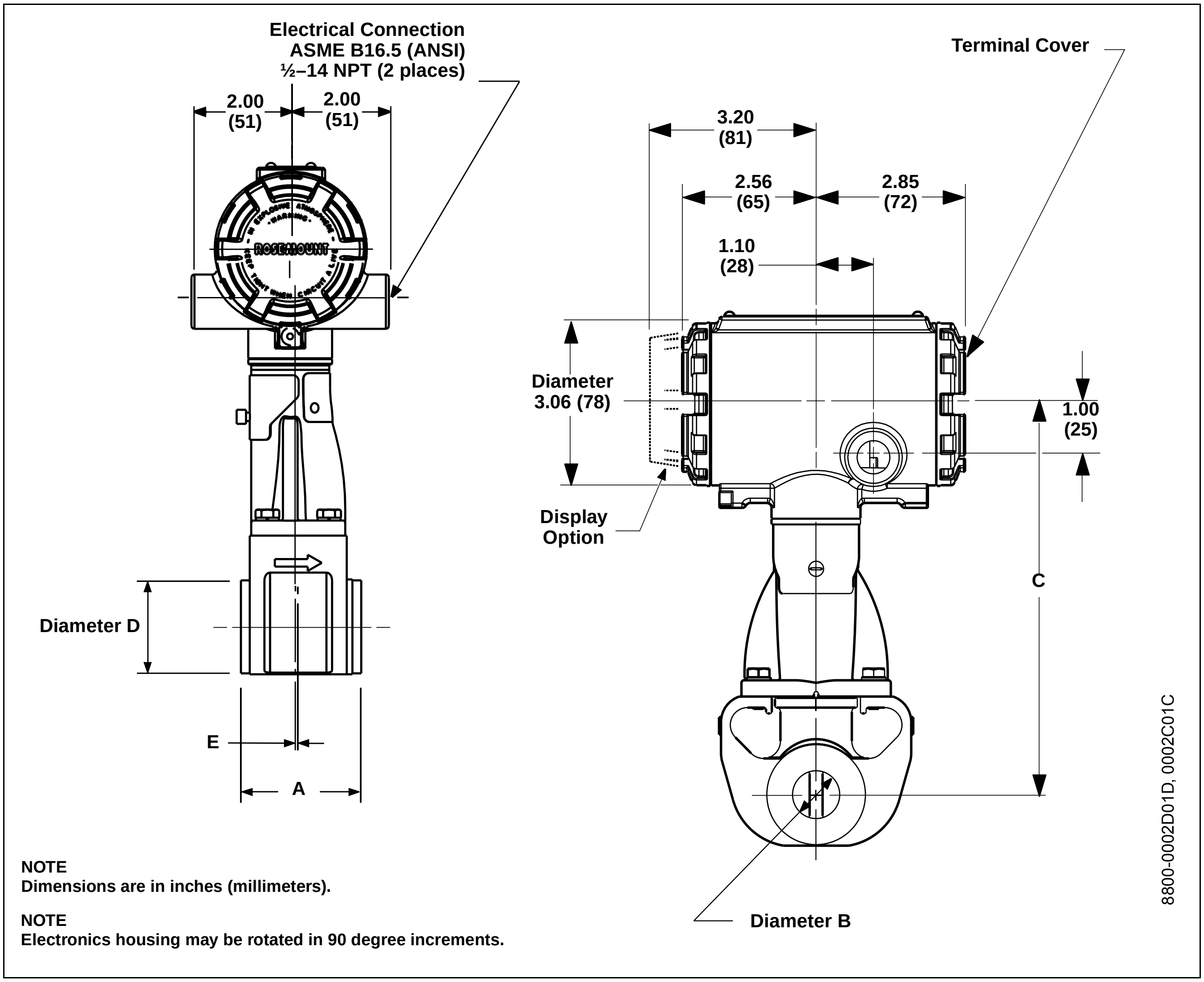


TABLE 2-7. Model 8800C - Stainless Steel Wafer.

Nominal Size Inch (mm)	Face-to-face A Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Diameter D Inch (mm)	E Inch (mm)	Weight lb (kg)(1)
½ (15)	2.56 (65)	0.54 (13.7)	7.63 (194)	1.38 (35.1)	0.23 (5.8)	7.3 (3.31)
1 (25)	2.56 (65)	0.95 (24.1)	7.74 (197)	1.98 (50.3)	0.23 (5.8)	7.6 (3.45)
1½ (40)	2.56 (65)	1.49 (37.8)	8.14 (207)	2.87 (72.9)	0.18 (4.6)	9.8 (4.45)

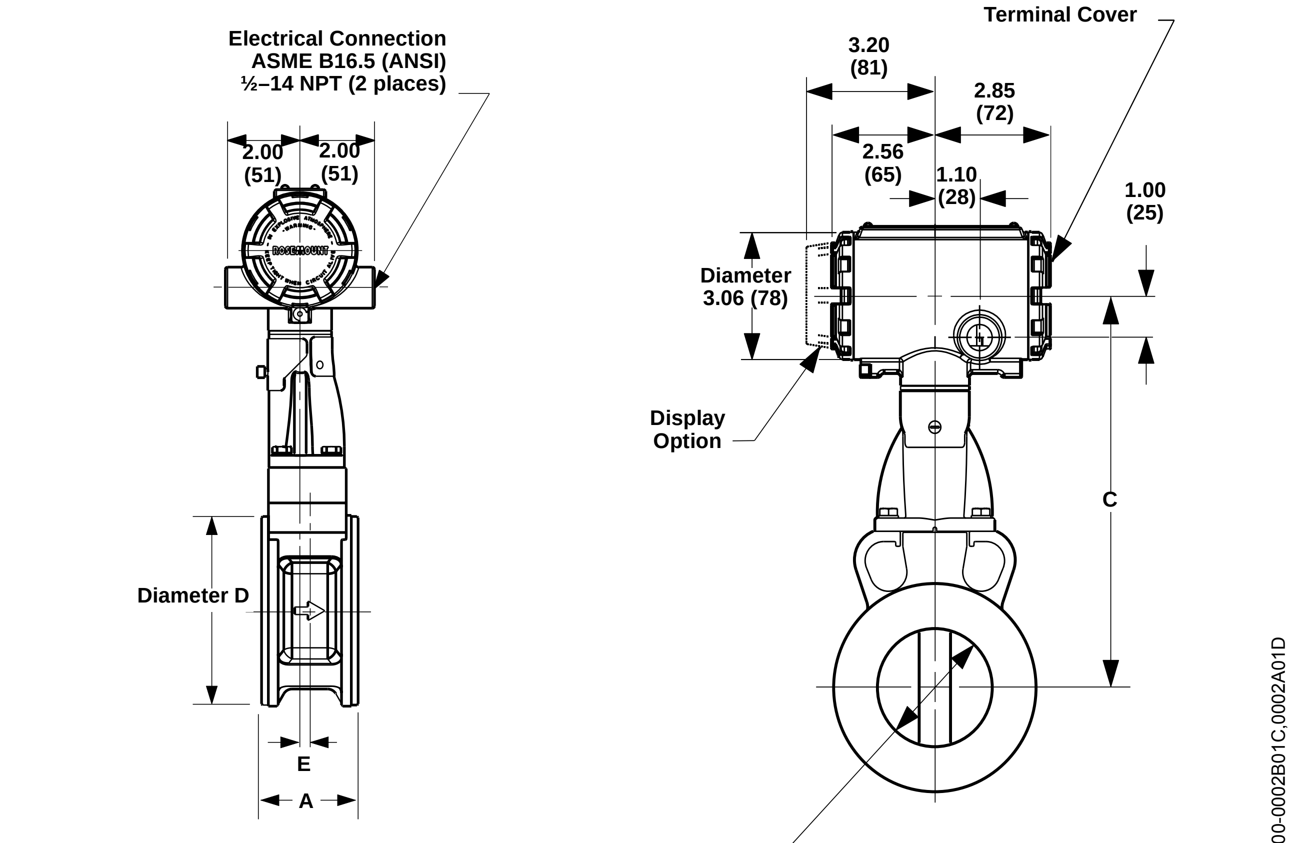
(1) Add 0.2 lb (0.1 kg) for display option.

TABLE 2-8. Model 8800A - Hastelloy Wafer.

Nominal Size Inch (mm)	Face-to-face A Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Diameter D Inch (mm)	E Inch (mm)	Weight lb (kg)(1)
½ (15)	2.44 (62.0)	0.54 (13.7)	7.63 (194)	1.38 (35.1)	0.17 (4.3)	7.2 (3.3)
1 (25)	2.44 (62.0)	0.95 (24.1)	7.74 (197)	1.98 (50.3)	0.17 (4.3)	7.6 (3.4)
1½ (40)	3.11 (79.0)	1.49 (37.8)	8.08 (205)	2.87 (72.9)	0.47 (11.9)	10.8 (4.9)

(1) Add 0.2 lb (0.1 kg) for display option.

Figure 2-12. Wafer-Style Dimensional Drawings (2- through 8-in. / 50 through 200 mm Line Sizes).



NOTE
Dimensions are in inches (millimeters).

NOTE
Electronics housing may be rotated in 90 degree increments.

TABLE 2-9. Model 8800C - Stainless Steel Wafer.

Nominal Size Inch (mm)	Face-to-face A Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Diameter D Inch (mm)	E Inch (mm)	Weight lb (kg)(1)
2 (50)	2.56 (65)	1.92 (49)	8.85 (225)	3.86 (98)	0.12 (3)	10.6 (4.81)
3 (80)	2.56 (65)	2.87 (73)	9.62 (244)	5.00 (127)	0.25 (6)	13.7 (6.21
4 (100)	3.42 (87)	3.79 (96)	10.48 (266)	6.20 (158)	0.44 (11)	21.4 (9.71)
6 (150)	4.99 (127)	5.70 (145)	10.75 (273)	8.50 (216)	1.11 (28)	49.2 (22.3)
8 (200)	6.60 (168)	7.55 (192)	11.67 (296)	10.62 (270)	0.89 (23)	85 (38.6)

(1) Add 0.2 lb (0.1 kg) for display option.

TABLE 2-10. Model 8800A - Hastelloy Wafer.

Nominal Size Inch (mm)	Face-to-face A Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Diameter D Inch (mm)	E Inch (mm)	Weight lb (kg)(1)
2 (50)	3.81 (97)	1.92 (49)	8.45 (215)	3.86 (98)	0.86 (22)	10.8 (4.9)
3 (80)	3.92 (100)	2.87 (73)	9.10 (231)	5.00 (127)	0.76 (19)	15.0 (6.8)
4 (100)	4.47 (114)	3.79 (96)	9.56 (243)	6.20 (158)	0.82 (21)	23.0 (10.4)
6 (150)	4.99 (127)	5.70 (145)	10.75 (273)	8.50 (216)	1.11 (28)	49.2 (22.3)
8 (200)	6.60 (168)	7.55 (192)	11.67 (296)	10.62 (270)	0.89 (23)	85 (38.6)

(1) Add 0.2 lb (0.1 kg) for display option.

Figure 2-13. Vortex Dual-Sensor Style Flowmeter Dimensional Drawings (1/2- through 8-in. / 15 through 200 mm Line Sizes).

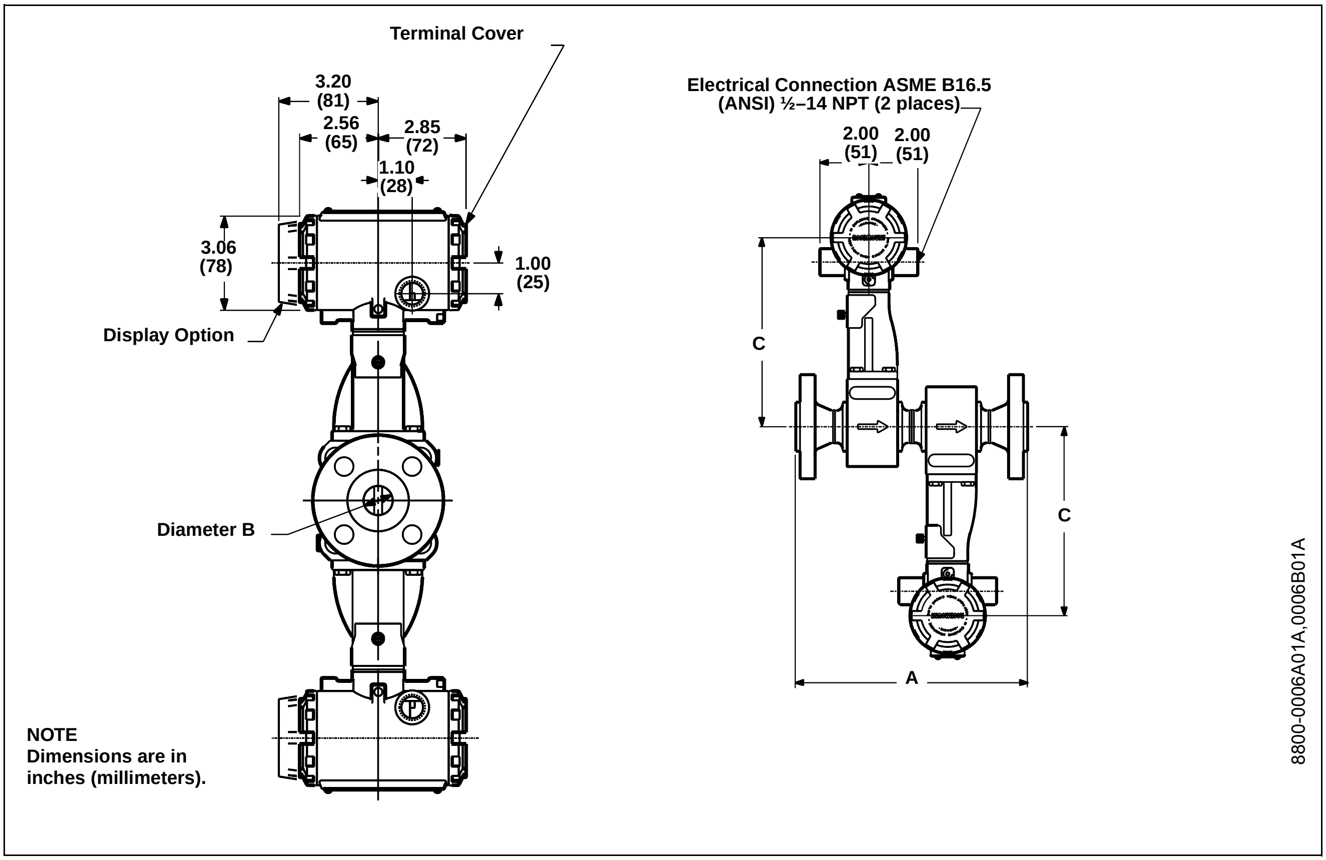


TABLE 2-11. Vortex Dual-Sensor Style Flowmeter
(1/2 through 1 1/2-in. / 15 through 40 mm Line Sizes).

Nominal Size Inch (mm)	Flange Rating	Face-to-face A Inch (mm)	A ANSI RTJ Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Weight lb (kg)(1)
½ (15)	Class 150	11.97 (304)	–	0.54 (13.7)	7.63 (194)	16.3 (7.4)
	Class 300	12.33 (313)	12.77 (324.4)	0.54 (13.7)	7.63 (194)	17.3 (7.9)
	Class 600	12.83 (326)	12.77 (324.4)	0.54 (13.7)	7.63 (194)	17.6 (8.0)
	PN 16/40	11.21 (285)	–	0.54 (13.7)	7.63 (194)	15.7 (7.1)
	PN 100	11.75 (299)	–	0.54 (13.7)	7.63 (194)	16.6 (7.6)
	JIS 10K/20K	11.4 (290)	–	0.54 (13.7)	7.63 (194)	17.1 (7.8)
	JIS 40K	12.4 (315)	–	0.54 (13.7)	7.63 (194)	20.6 (9.3)
1 (25)	Class 150	15.14 (385)	15.64 (397.4)	0.95 (24.1)	7.74 (197)	26.0 (11.8)
	Class 300	15.64 (397)	16.14 (410.1)	0.95 (24.1)	7.74 (197)	29.2 (13.3)
	Class 600	16.14 (410)	16.14 (410.1)	0.95 (24.1)	7.74 (197)	29.5 (13.4)
	PN 16/40	13.9 (353)	–	0.95 (24.1)	7.74 (197)	22.1 (10.0)
	PN 100	15.32 (389)	–	0.95 (24.1)	7.74 (197)	33.3 (15.1)
	JIS 10K/20K	14.1 (358)	–	0.95 (24.1)	7.74 (197)	22.1 (10.0)
	JIS 40K	15.5 (394)	–	0.95 (24.1)	7.74 (197)	25.8 (11.7)
1 ½ (40)	Class 150	11.33 (288)	11.83 (300.5)	1.49 (37.8)	8.08 (205)	33.3 (15.1)
	Class 300	11.83 (301)	12.33 (313.2)	1.49 (37.8)	8.08 (205)	38.4 (17.4)
	Class 600	12.45 (316)	12.45 (316.2)	1.49 (37.8)	8.08 (205)	41.6 (18.9)
	PN 16/40	9.99 (254)	–	1.49 (37.8)	8.08 (205)	35.3 (16.0)
	PN 100	11.33 (288)	–	1.49 (37.8)	8.08 (205)	43.4 (19.7)
	JIS 10K/20K	10.4 (264)	–	1.49 (37.8)	8.08 (205)	27.9 (12.6)
	JIS 40K	11.5 (292)	–	1.49 (37.8)	8.08 (205)	34.9 (15.8)

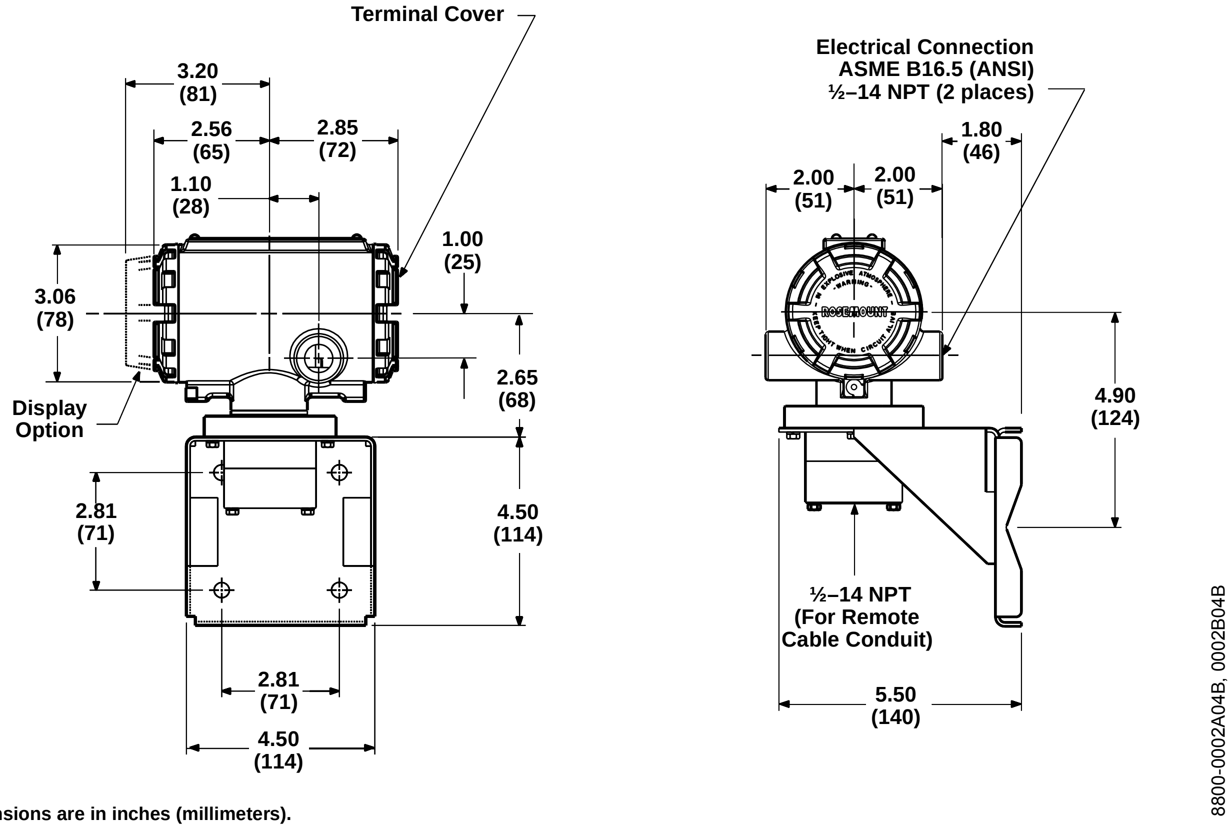
(1) Add 0.4 lb (0.2 kg) for display option.

TABLE 2-12. Vortex Dual-Sensor Style Flowmeter (2- through 8-in. / 50 through 200 mm Line Sizes). (Refer to Figure 2-13)

Nominal Size Inch (mm)	Flange Rating	Face-to-face A Inch (mm)	A ANSI RTJ Inch (mm)	Diameter B Inch (mm)	C Inch (mm)	Weight lb (kg)(1)
2 (50)	Class 150	13.06 (332)	13.56 (344.4)	1.92 (48.8)	8.49 (216)	34.0 (15.4)
	Class 300	13.56 (344)	14.06 (357.1)	1.92 (48.8)	8.49 (216)	37.3 (16.9)
	Class 600	14.32 (364)	14.32 (363.7)	1.92 (48.8)	8.49 (216)	42.5 (19.3)
	PN 16/40	11.84 (301)	–	1.92 (48.8)	8.49 (216)	35.0 (15.9)
	PN 64	12.94 (329)	–	1.92 (48.8)	8.49 (216)	43.3 (19.7)
	PN 100	13.42 (341)	–	1.92 (48.8)	8.49 (216)	49.6 (22.5)
	JIS 10K	11.5 (292)	–	1.92 (48.8)	8.49 (216)	29.1 (13.2)
	JIS 20K	12.1 (307)	–	1.92 (48.8)	8.49 (216)	29.7 (13.5)
	JIS 40K	13.6 (345)	–	1.92 (48.8)	8.49 (216)	37.9 (17.2)
3 (80)	Class 150	14.30 (363)	14.80 (375.9)	2.87 (72.9)	9.05 (230)	58.0 (26.3)
	Class 300	15.04 (382)	15.66 (397.9)	2.87 (72.9)	9.05 (230)	66.0 (29.9)
	Class 600	15.80 (401)	15.80 (401.3)	2.87 (72.9)	9.05 (230)	71.5 (32.4)
	PN 16/40	13.36 (339)	–	2.87 (72.9)	9.05 (230)	52.2 (24.9)
	PN 64	14.46 (367)	–	2.87 (72.9)	9.05 (230)	64.4 (29.2)
	PN 100	14.94 (380)	–	2.87 (72.9)	9.05 (230)	74.3 (33.7)
	JIS 10K	12.3 (312)	–	2.87 (72.9)	9.05 (230)	41.0 (18.6)
	JIS 20K	13.7 (348)	–	2.87 (72.9)	9.05 (230)	48.4 (22.0)
	JIS 40K	15.5 (394)	–	2.87 (72.9)	9.05 (230)	63.4 (28.8)
4 (100)	Class 150	15.24 (387)	15.74 (399.8)	3.79 (96.3)	9.60 (244)	76.0 (34.5)
	Class 300	16.00 (406)	16.62 (422.2)	3.79 (96.3)	9.60 (244)	94.5 (42.9)
	Class 600	17.74 (451)	17.74 (450.6)	3.79 (96.3)	9.60 (244)	121.5 (55.1)
	PN 16	13.34 (339)	–	3.79 (96.3)	9.60 (244)	62.2 (28.2)
	PN 40	14.36 (365)	–	3.79 (96.3)	9.60 (244)	71.1 (32.2)
	PN 64	15.38 (391)	–	3.79 (96.3)	9.60 (244)	86.4 (39.2)
	PN 100	16.32 (415)	–	3.79 (96.3)	9.60 (244)	104.1 (47.3)
	JIS 10K	13.6 (345)	–	3.79 (96.3)	9.60 (244)	55.4 (25.1)
	JIS 20K	13.6 (345)	–	3.79 (96.3)	9.60 (244)	63.2 (28.7)
	JIS 40K	16.8 (427)	–	3.79 (96.3)	9.60 (244)	93.7 (42.5)
6 (150)	Class 150	19.42 (493)	19.92 (506.0)	5.70 (144.8)	10.79 (274)	128.0 (58.1)
	Class 300	20.18 (513)	20.80 (528.4)	5.70 (144.8)	10.79 (274)	168.0 (76.2)
	Class 600	22.16 (563)	22.16 (562.9)	5.70 (144.8)	10.79 (274)	226.0 (102.5)
	PN 16	16.76 (426)	–	5.70 (144.8)	10.79 (274)	107.7 (48.8)
	PN 40	18.32 (465)	–	5.70 (144.8)	10.79 (274)	132.4 (60.0)
	PN 64	19.90 (505)	–	5.70 (144.8)	10.79 (274)	180.6 (81.9)
	PN 100	21.48 (546)	–	5.70 (144.8)	10.79 (274)	217.2 (98.5)
	JIS 10K	18.5 (470)	–	5.70 (144.8)	10.79 (274)	124.0 (56.2)
	JIS 20K	18.5 (470)	–	5.70 (144.8)	10.79 (274)	141.9 (64.4)
	JIS 40K	22.0 (559)	–	5.70 (144.8)	10.79 (274)	220.1 (99.8)
8 (200)	Class 150	24.01 (610)	24.51 (622.6)	7.55 (191.8)	11.71 (298)	191.4 (86.8)
	Class 300	24.77 (629)	25.39 (645.0)	7.55 (191.8)	11.71 (298)	252.0 (114.3)
	Class 600	27.01 (686)	27.13 (689.2)	7.55 (191.8)	11.71 (298)	336.0 (152.4)
	PN 10	20.89 (531)	–	7.55 (191.8)	11.71 (298)	166.0 (75.3)
	PN 16	20.89 (531)	–	7.55 (191.8)	11.71 (298)	164.7 (74.7)
	PN 25	22.31 (567)	–	7.55 (191.8)	11.71 (298)	191.1 (86.7)
	PN 40	22.93 (582)	–	7.55 (191.8)	11.71 (298)	213.0 (96.6)
	PN 64	24.67 (627)	–	7.55 (191.8)	11.71 (298)	278.3 (126)
	PN 100	26.25 (667)	–	7.55 (191.8)	11.71 (298)	357.2 (162)
	JIS 10K	22.6 (574)	–	7.55 (191.8)	11.71 (298)	178.2 (80.8)
	JIS 20K	22.6 (574)	–	7.55 (191.8)	11.71 (298)	202.6 (91.9)
	JIS 40K	27.0 (686)	–	7.55 (191.8)	11.71 (298)	324.0 (147.0)

(1) Add 0.4 Lb (0.2 kg) for display option.

Figure 2-14. Dimensional Drawings for Remote Mount Transmitters.



NOTE
Dimensions are in inches (millimeters).

Figure 2-15. Dimensional Drawings for Remote Mount Wafer-Style Flowmeters (1/2- through 8-in. / 15 through 200 mm Line Sizes).

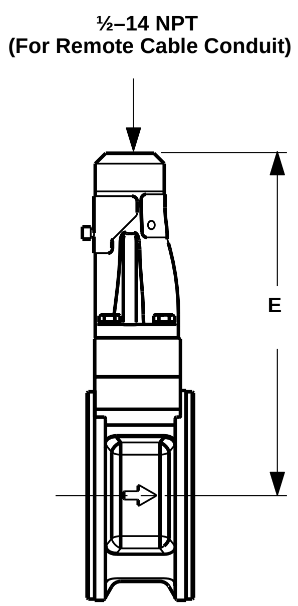


TABLE 2-13. Model 8800C - Stainless Steel Wafer.

Nominal Size Inch (mm)	E Wafer Style Inch (mm)
½ (15)	6.4 (163)
1 (25)	6.5 (165)
1½ (40)	6.9 (175)
2 (50)	7.6 (193)
3 (80)	8.3 (211)
4 (100)	9.2 (234)
6 (150)	9.5 (241)
8 (200)	10.4 (264)

TABLE 2-14. Model 8800A - Hastelloy Wafer.

Nominal Size Inch (mm)	E Wafer Style Inch (mm)
½ (15)	6.4 (163)
1 (25)	6.5 (165)
1½ (40)	6.8 (173)
2 (50)	7.2 (183)
3 (80)	7.8 (198)
4 (100)	8.3 (211)
6 (150)	9.5 (241)
8 (200)	10.4 (264)

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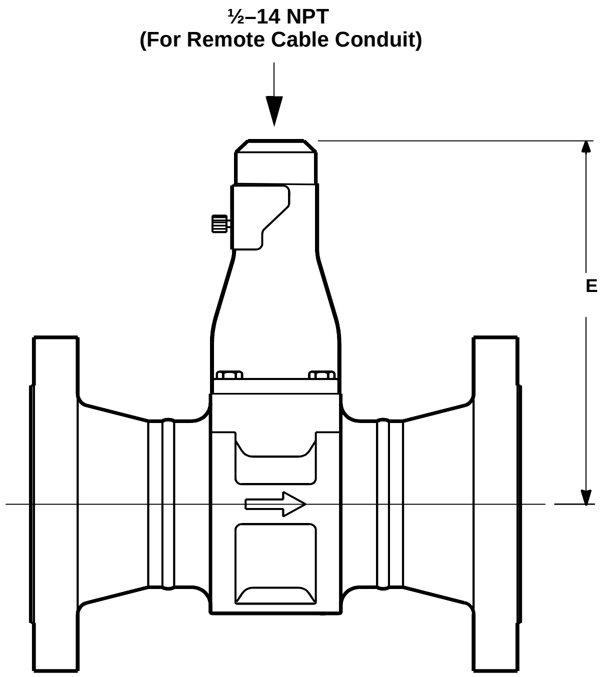
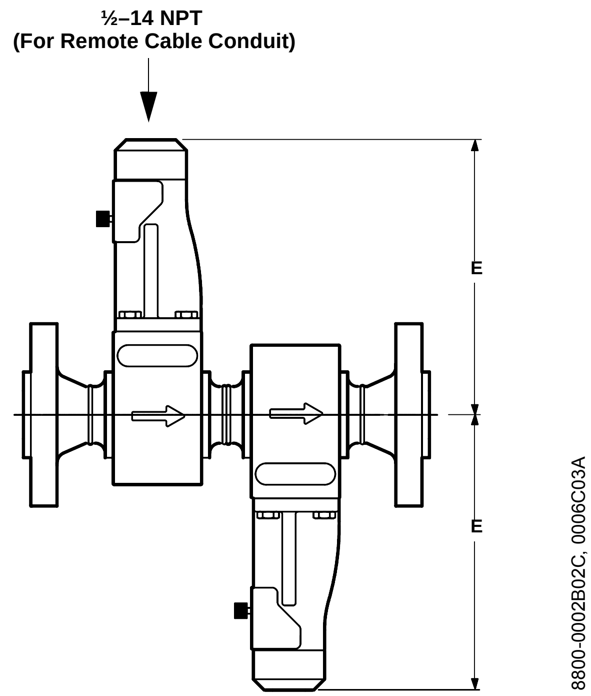
NOTE
Dimensions are in inches (millimeters).

Figure 2-16. Dimensional Drawings for Flanged- and Dual-Sensor Flanged-Style Remote Mount Flowmeters (1/2- through 8-inch / 15 through 200 mm Line Sizes).



Flanged Flowmeter



Dual-Sensor Flanged-Style Flowmeter

NOTE
Dimensions are in inches (millimeters).

TABLE 2-15. Remote Mount, Flanged- and Dual-Sensor Flowmeter Dimensions.

Nominal Size Inch (mm)	E Flange Style Inch (mm)
½ (15)	6.4 (163)
1 (25)	6.5 (165)
1½ (40)	6.9 (175)
2 (50)	7.2 (183)
3 (80)	7.8 (198)
4 (100)	8.3 (211)
6 (150)	9.5 (241)
8 (200)	10.4 (264)

ELECTRICAL CONSIDERATIONS

Proper electrical installation is necessary to prevent errors due to electrical noise and interference. Shielded cable should be used for best results in electrically noisy environments.

Power Supply

The transmitter requires a minimum of 9 V dc and a maximum of 32 V dc at the transmitter power terminals.

NOTES

- **Do not** exceed 32 V dc at the transmitter terminals.
- **Do not** apply ac line voltage to the transmitter terminals.

Improper supply voltage can damage the transmitter.

Power Conditioning

Each fieldbus power supply **requires** a power conditioner to decouple the power supply output from the fieldbus wiring segment.

Field Wiring

All power to the transmitter is supplied over the segment wiring. Use shielded, twisted pair for best results. For new installations or to get maximum performance, twisted pair cable designed especially for fieldbus should be used. Table 2-16 details cable characteristics and ideal specifications.

TABLE 2-16.
Ideal Cable Specifications for Fieldbus Wiring.

Characteristic	Ideal Specification
Impedance	100 Ohms ± 20 % at 31.25 kHz
Wire Size	18 AWG (0,8 mm^2)
Shield Coverage	90 %
Attenuation	3 db/km
Capacitive Unbalance	2 nF/km

NOTE
The number of devices on a fieldbus segment is limited by the power supply voltage, the resistance of the cable, and the amount of current drawn by each device.

Transmitter Wiring Connection

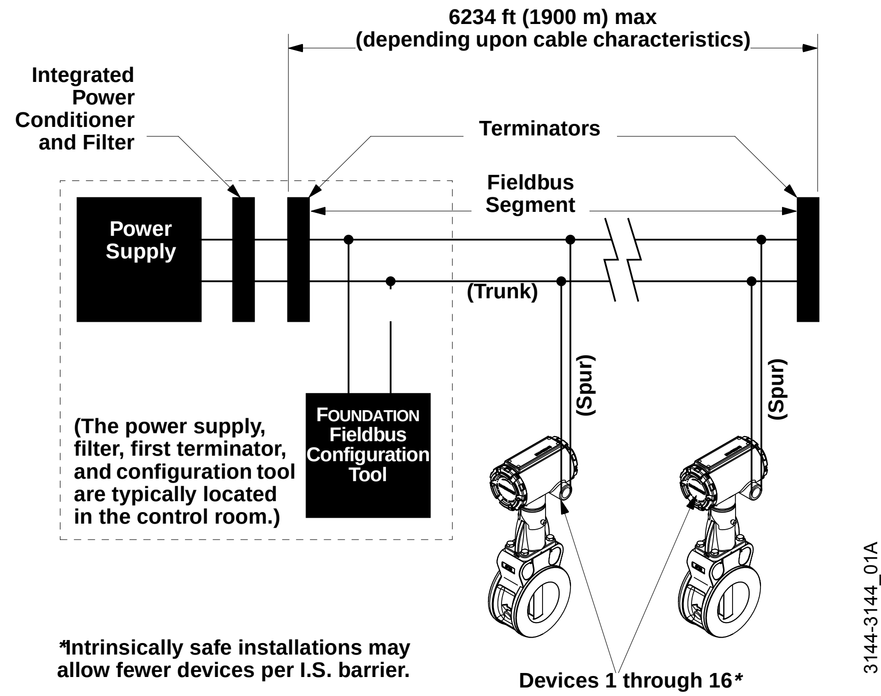
To make the transmitter wiring connection, remove the FIELD TERMINALS end cover on the electronics housing. Connect the power leads to the positive (+) and negative (–) terminals. The power terminals are polarity insensitive: the polarity of the dc power leads does not matter when connecting to the power terminals.

When wiring to screw terminals, crimped lugs are recommended. Tighten the terminals to ensure adequate contact. No additional power wiring is required.

Both transmitter covers must be fully engaged to meet explosion proof requirements. Do not remove the transmitter covers in an explosive atmosphere when the transmitter is powered.

See “Safety Messages” on page 2-1 for complete warning information.

Figure 2-17. Model 8800C Transmitter Field Wiring.



Remote Electronics

If you order one of the remote electronics options (options R10, R20, R30, or RXX), the flowmeter assembly will be shipped in two parts:

1. The meter body with an adapter installed in the support tube and an interconnecting coaxial cable attached to it.
2. The electronics housing installed on a mounting bracket.

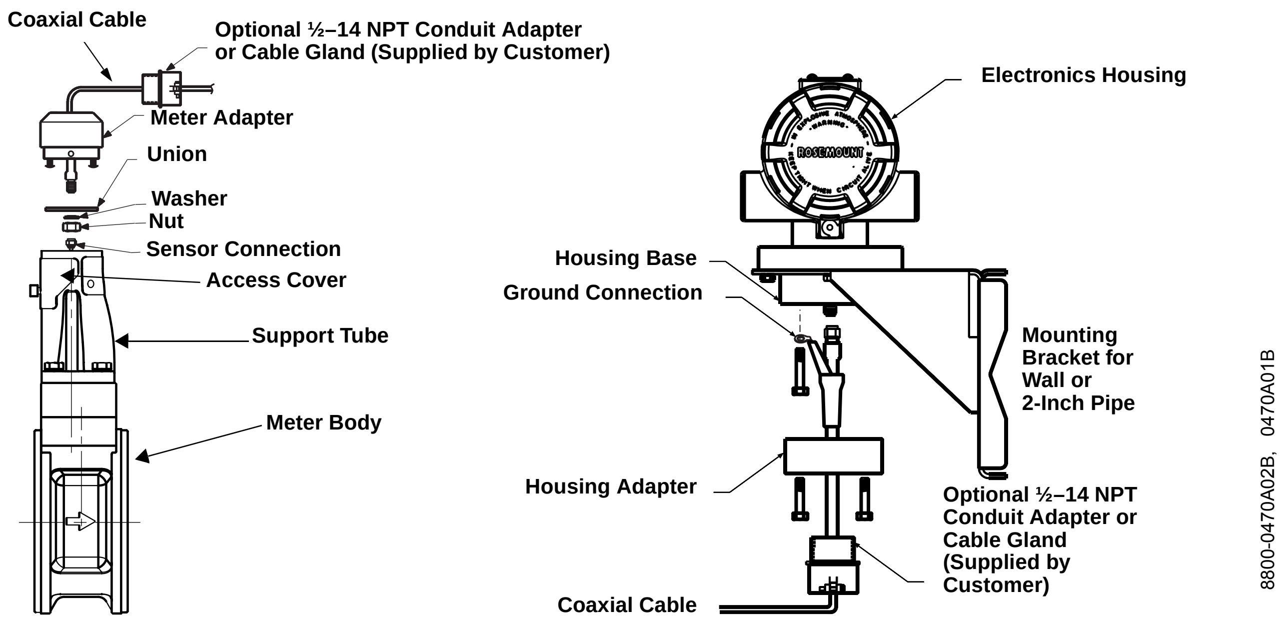
Mounting

Mount the meter body in the process flow line as described earlier in this section (see “Flowmeter Orientation” on page 2-2). Mount the bracket and electronics housing in the desired location. The housing can be repositioned on the bracket to facilitate field wiring and conduit routing.

Cable Connections

Refer to Figure 2-18 and the following instructions to connect the loose end of the coaxial cable to the electronics housing.

Figure 2-18. Remote Electronics Installation.



1. If you plan to run the coaxial cable in conduit, carefully cut the conduit to the desired length to provide for proper assembly at the housing. A junction box may be placed in the conduit run to provide a space for extra coaxial cable length.
2. Slide the conduit adapter or cable gland over the loose end of the coaxial cable and fasten it to the adapter on the meter body support tube.
3. If using conduit, route the coaxial cable through the conduit.
4. Place a conduit adapter or cable gland over the end of the coaxial cable.
5. Remove the housing adapter from the electronics housing.
6. Slide the housing adapter over the coaxial cable.
7. Remove one of the four housing base screws.
8. Bend the round lug so it is perpendicular to the cable.
9. Attach and securely tighten the coaxial cable nut to the connection on the electronics housing.
10. Attach the coaxial cable ground connection round lug to the housing via the housing base ground screw. Use the 1½-inch screw to go through the round lug and attach to the housing base.
11. Align the housing adapter with the housing and attach with three screws.
12. Tighten the conduit adapter or cable gland to the housing adapter.

CAUTION
To prevent moisture from entering the coaxial cable connections, install the interconnecting coaxial cable in a single dedicated conduit run or use sealed cable glands at both ends of the cable.

Calibration

Model 8800C Flowmeters are wet-calibrated at the factory and need no further calibration during installation. The calibration factor (K-factor) is stamped on each meter body and is entered into the electronics.

SOFTWARE CONFIGURATION

To complete the installation of the Model 8800C Vortex Flowmeter, configure the software to meet the requirements of your application. If the flowmeter was pre-configured at the factory, it may be ready to install. If not, refer to Section 3: Flowmeter Operation.

Tagging

Commissioning Tag

Your Model 8800C Flowmeter has been supplied with a removable commissioning tag that contains both the Device ID and a space to record the device tag. The Device ID is a unique code that identifies a particular device in the absence of a device tag. The device tag is used as an operational identification for the device and is usually defined by the Piping and Instrumentation Diagram (P & ID).

When commissioning more than one device on a fieldbus segment, it can be difficult to identify which device is at a particular location. The removable tag provided with the transmitter can aid in this process by linking the Device ID and a physical location. For each device on the segment, the installer should note the physical location in both places on the removable commissioning tag and tear off the bottom portion. The bottom portion of the tags can be used for commissioning the segment in the control system.

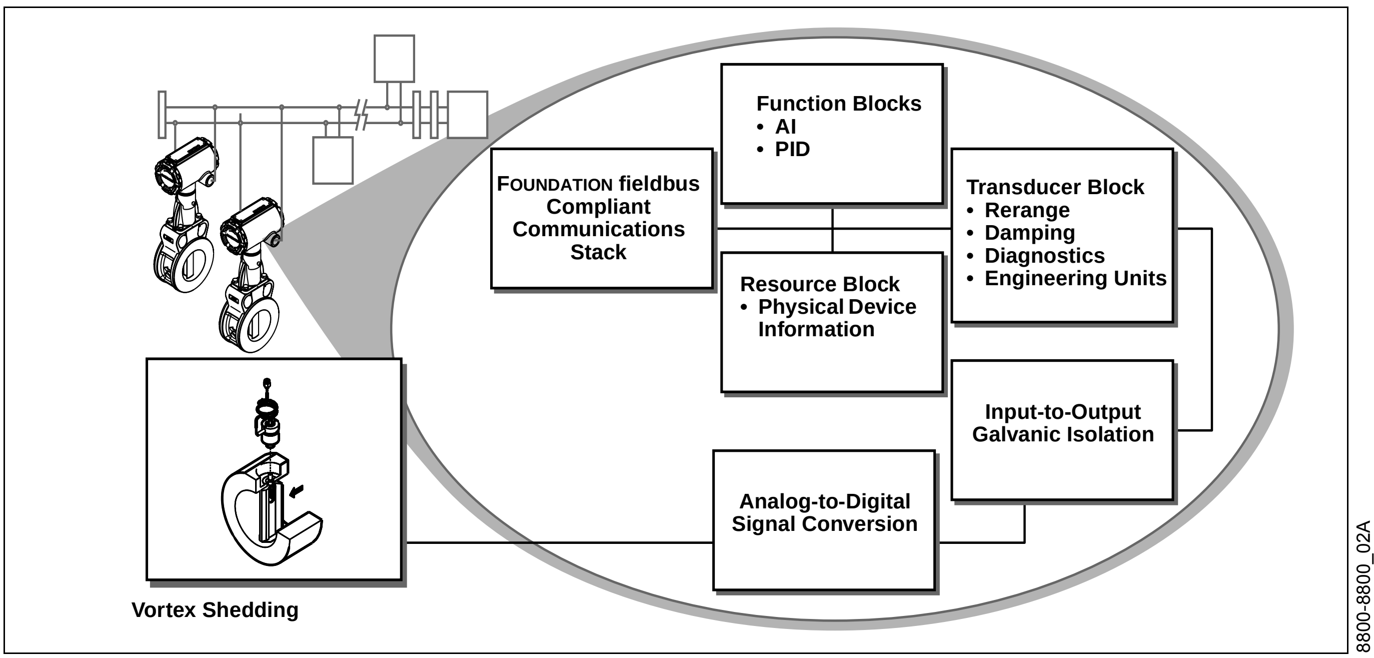
Section **3**

Flowmeter Operation

Section 3 covers basic operation, software functionality, and basic configuration procedures for the Model 8800C Vortex Flowmeter with FOUNDATION fieldbus. For more information about the FOUNDATION fieldbus technology and the function blocks used in the transmitter, refer to Section 4: Transducer Block, Section 5: Resource Block, Appendix A: Foundation™ fieldbus Technology and Fieldbus Function Blocks, Appendix B: Analog Input (AI) Function Block, and Appendix C: PID Function Block.

Figure 3-1 illustrates how the flow signal is channeled through the transmitter.

Figure 3-1. Functional Block Diagram for the Model 8800C Vortex Flowmeter with FOUNDATION Fieldbus.



OVERVIEW

Each FOUNDATION fieldbus configuration tool or host device has a different way of displaying and performing configurations. Some will use Device Descriptions (DD) and DD Methods to make configuring and displaying data consistent across host platforms. Since there is no requirement that a configuration tool or host support these features, this section describes how to reconfigure the device manually.

ASSIGNING DEVICE TAG AND NODE ADDRESS

The Model 8800C Flowmeter is shipped with a blank tag and a temporary address to allow a host to automatically assign an address and a tag. If the tag or address need to be changed, use the features of the configuration tool. The tools do the following:

- Change the address to a temporary address (248-251).
- Change the tag to a new value.
- Change the address to a new address.

When the device is at a temporary address, only the tag and address can be changed or written to. The resource, transducer, and function blocks are all disabled.

CONFIGURING THE TRANSDUCER BLOCK

Unless otherwise specified at the time of purchase, the transducer block will come preconfigured for liquid (water) through a nominal schedule 40, 3 in. pipe at a process temperature of 68 °F (20 °C).

FLOW-SPECIFIC BLOCK CONFIGURATION

AI Block

The Analog Input (AI) function block provides the primary interface of the measurement to the control and/or monitoring systems. The interface between the AI block and the transducer block is through the following 3 parameters:

- The CHANNEL parameter defines which transducer block measurement is used by the AI block. In the Model 8800C Flowmeter, only one channel is available: AI1.CHANNEL = 1 (Flow).
- The second parameter is the XD_SCALE.UNITS_INDX. The default configuration is feet per second (ft/s).
- Finally, since the flow measurement from the transducer block is in the correct units, L_TYPE is configured as Direct. L_TYPE is usually only changed to Indirect or Indirect-Square-Root if the measurement type changes.

Please note that these parameters must be changed in the following order:

1. CHANNEL
2. XD_SCALE.UNITS_INDEX
3. L_TYPE

NOTE
Please refer to Appendix B: Analog Input (AI) Function Block for more details on configuring and troubleshooting the AI Block.

GENERAL BLOCK CONFIGURATION

In general, only the transducer block and AI block have configurations for flow-specific parameters. All other function blocks are configured by linking the AI block to other blocks to be used for control and/or monitoring applications. See the appropriate function block appendix for specific application examples.

CONFIGURING LINKS AND SCHEDULING BLOCK EXECUTION

Without configuring the links between blocks and scheduling the blocks to execute in the proper order, the application will not work correctly. Most hosts and/or configuration tools make this task a simple matter by using a Graphical User Interface (GUI).

Figure 3-2. Measurement Configuration.

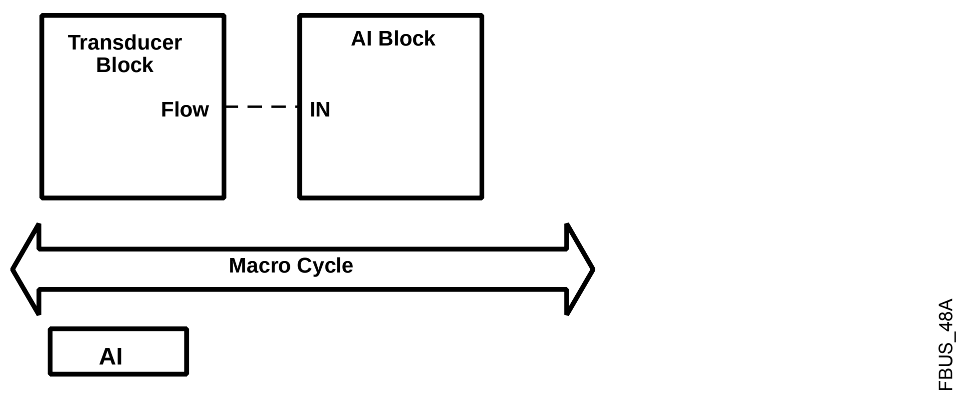
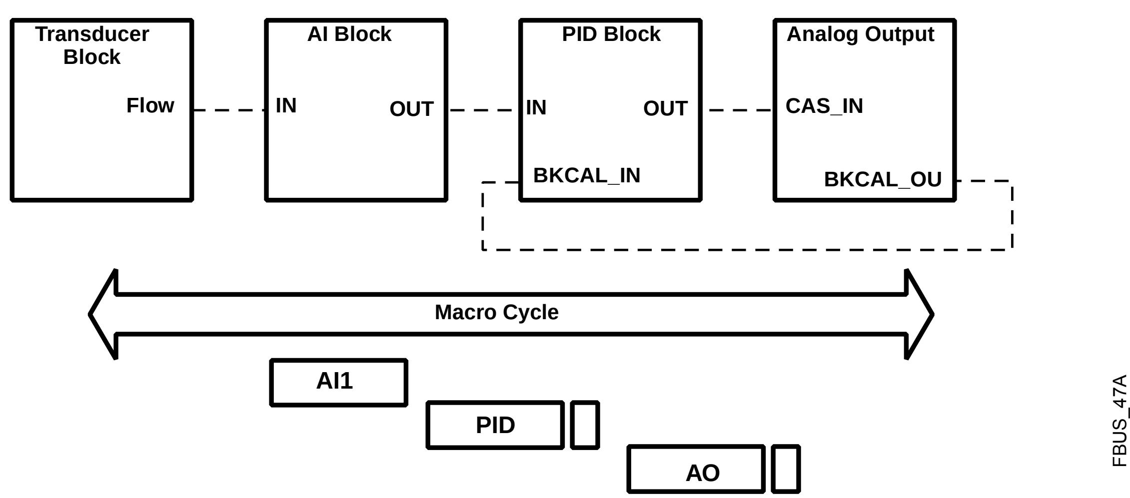


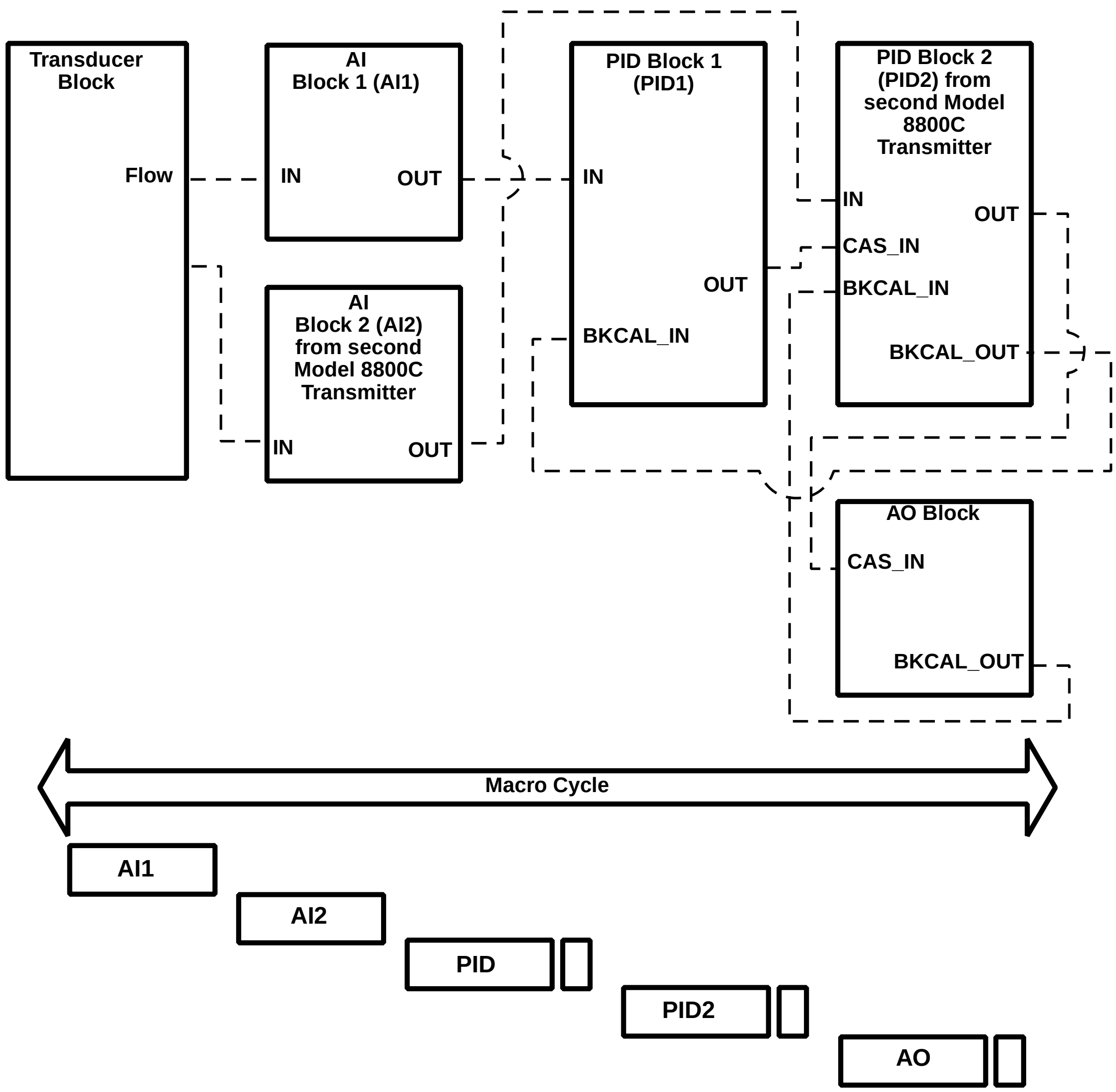
Figure 3-3. Control Configuration.



Cascade Control

Cascade control applications require two inputs. The configuration is to link the output of one AI block into the PID block in the Model 8800C transmitter and to link the AI block of a second Model 8800C transmitter into the PID block of that transmitter. Another set of links between the second PID and the AO block, located in the control valve, is required (see Figure 3-4).

Figure 3-4. Cascade Control Configuration.

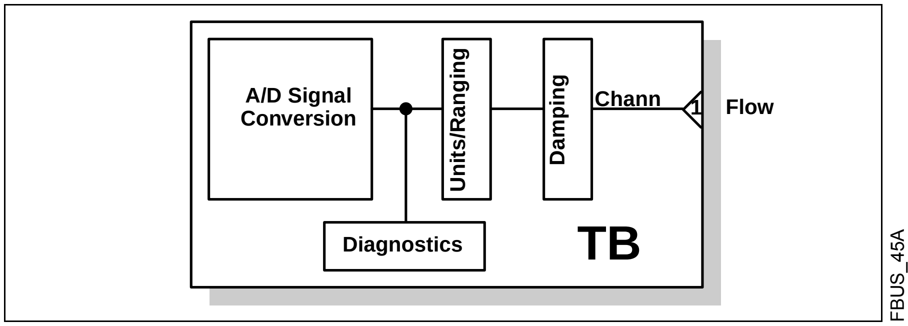


Section 4 Transducer Block

OVERVIEW

Section 4 contains information on the Model 8800C Vortex Flowmeter transducer block. Descriptions of all transducer block parameters, errors, and diagnostics are listed. Also, the modes, alarm detection, status handling, application information, and troubleshooting are discussed.

Figure 4-1. Transducer Block Diagram.



Channel Definitions

Only a single channel is defined in the Model 8800C Flowmeter. Channel 1 provides flow measurements to the AI block.

Quick Transducer Block Configuration Guide

Proper configuration of the Model 8800C Vortex Flowmeter is essential for accurate performance. The following is a quick configuration guide for those already familiar with vortex meters, especially the Model 8800C.

For most parameters configured in the Model 8800C, the transmitter must perform extensive calculations to derive internal parameters used to accurately measure flow. It is recommended that each parameter in the Transducer Block be configured and sent to the transmitter individually. If too many parameter changes are sent to the transmitter at one time, the transmitter will return an error. The parameters not accepted will have to be resent.

Configuration Order

The Model 8800C Transducer Block parameters can be configured in any order, but the following is offered as a recommended procedure and can be used as a checklist for configuration items.

1. K Factor
2. Service Type
3. Pipe Inside Diameter
4. Pipe Inside Diameter Units
5. Damping
6. Flange Type
7. Wetted Material
8. Meter Body Number
9. Process Temperature
10. Process Temperature Units
11. Filter Auto Adjust (to approximate process fluid density)
12. Meter Display. (If optional local display is installed.)
13. AI Block - Channel. Set to Flow.
14. AI Block - XD_SCALE.UNITS_INDEX. Select engineering units for flow.
15. AI Block - L_TYPE. Usually set to Direct.

If mass flow engineering units are selected (lb/sec, kg/sec, etc.) then you must configure:

1. Process Density
2. Process Density Units

If Standard/Normal engineering units are selected (Normal m^3/sec, Standard ft^3/sec, etc.) and you want the transmitter to calculate the Density Ratio, then you must configure:

1. Base Temperature
2. Base Temperature Units
3. Base Pressure (Absolute)
4. Base Pressure Units
5. Base Compressibility
6. Process Pressure (Absolute)
7. Process Pressure Units
8. Process Compressibility

If Standard/Normal engineering units are selected (Normal m^3/sec, Standard ft^3/sec, etc.) and you have the Density Ratio, then you must configure:

1. Process Density Ratio

Using the Resource Block RESTART parameter, initiate a PROCESSOR restart. When the transmitter comes back on line, verify your configuration. This will ensure that all parameters have been properly stored in nonvolatile memory.

This configuration process will be sufficient for most applications.

Parameters and Descriptions

TABLE 4-1. Transducer Block Parameters.

Parameter	Index Number	Definition
ALERT_KEY	4	The alert key is the identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
BASE_COMPRESSIBILITY	57	Base compressibility is the compressibility of the process fluid at the base temperature and base pressure. It is used to calculate the PROCESS_DENSITY_RATIO and is not limit checked.
BASE_PRESSURE	55	Base pressure is the pressure from which the PROCESS_DENSITY_RATIO is calculated.
BASE_PRESSURE_UNITS	56	The engineering units of base pressure: 1137 = bar (absolute) 1142 = pounds per square inch (absolute) 1545 = Megapascals (absolute) 1547 = Kilopascals (absolute) 1557 = Kilograms per square centimeter (absolute)
BASE_TEMP_UNITS	54	The engineering units of base temperature: 1001 = °C 1002 = °F
BASE_TEMPERATURE	53	The configured base temperature is the temperature from which the PROCESS_DENSITY_RATIO is calculated.
BLOCK_ALM	8	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the status parameter. As soon as the unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	6	This parameter reflects the error status of the hardware or software components associated with a block. The parameter is a bit string, so multiple errors may be shown.
CAL_MIN_SPAN	18	CAL_MIN_SPAN is the minimum span that must be used between the calibration high and low points.
CAL_POINT_HI	16	CAL_POINT_HI is the value of the primary value measurement used for the high calibration point.
CAL_POINT_LO	17	CAL_POINT_LO is the value of the primary value measurement used for the low calibration point.
CAL_UNIT	19	CAL_UNIT specifies the units used for the calibration inputs.
COLLECTION_DIRECTORY	12	The collection directory specifies the number, starting indices, and DD item IDs of the data collections in each transducer within a transducer block.
COMPD_K_FACTOR	33	This parameter represents the K-factor after it has been compensated for process temperature, materials, installation effects, etc. Units are reflected in K_FACTOR_UNITS.
DAMPING	30	Damping is the sampling interval used to smooth output using a first-order linear filter. Limits are 0.2 to 255 seconds.
ELECTRONICS_STATUS	69	This parameter represents the transducer block electronics status. See “Diagnostics” on page 4-9.
FILTER_AUTO_ADJUST	42	Selecting a fluid density close to the process density will adjust the Trigger Level, Low Flow Cutoff, and Low Pass Filter to values that will work well for most applications.
FLANGE_TYPE	36	Flange type specifies the wafer or the flange construction material (i.e. ANSI 150, ANSI 300, ANSI 600, PN64, JIS 10K, etc.). Flange type is used as an input to the compensated K-factor calculation.
INSTALLATION_EFFECTS	32	An adjustment to the Compensated K-Factor to account for less than ideal upstream piping effects.
K_FACTOR	31	The K-factor is the meter body calibration number. Units are reflected in K_FACTOR_UNITS.
K_FACTOR_UNITS	34	K-factor units are the engineering units to be applied to the K_FACTOR and COMPD_K_FACTOR. 0 = Pulses per gallon

Parameter	Index Number	Definition
LFC_IN_ENG_UNITS	44	This read-only parameter will indicate Low Flow Cutoff in currently configured engineering units.
LINEAR_TYPE	27	This parameter represents the linearization type used to describe the behavior of the sensor output. 1 = linear with input
LOW_FLOW_CUTOFF	43	The low-flow cutoff (LFC) represents the minimum reportable flow rate. For flow below this rate, the flow rate will damp to zero. The rate can be set to 48 discrete values representing vortex shedding frequencies from 0.9 to 4160 Hz.
LOW_PASS_CODE	42	The low pass code setting determines the corner frequency of the digital low pass filter. There are 29 discrete values representing frequencies from 0.1 to 3414 Hz. The code has a range of values from 2 to 30.
MAX_SIM_VALUE	67	This is the maximum simulation value that the internal signal can supply. The units for this parameter are determined by the Simulation_Units parameter, either percent of range or currently configured PV Engineering Units.
METER_BODY_NUMBER	40	The meter body number is stamped on a tag attached to the meter body. The meter body construction is used as an input to the compensated K-factor calculation.
METER_DISPLAY	41	This parameter is used to configure the values that will be displayed on the LCD (if installed). This parameter is a bit string, so more than one item can be selected at a time. Each of the items selected will be displayed for approximately 3 seconds before moving on to the next item.
MODE_BLK	5	The actual, target, permitted, and normal modes of the block: Target: The mode "to go to" Actual: The mode the "block is currently in" Permitted: Allowed modes that the target may take on Normal: Most common mode for the target
PIPE_ID_UNITS	39	The engineering units of the mating pipe inside diameter: 1013 = mm 1019 = in.
PIPE_INSIDE_DIAM	38	This parameter represents the mating pipe inside diameter. This value is used to calculate velocity flow and as an input to the COMPD_K_FACTOR calculation.
PRIMARY_VALUE	14	Primary value is the value and status of the measurement.
PRIMARY_VALUE_RANGE	15	This parameter represents the high and low range limit values, the engineering units code, and the number of digits to the right of the decimal point to be used in displaying the primary value.
PRIMARY_VALUE_TYPE	13	The primary value type is the type of measurement represented by the primary value. 101 = Volumetric Flow
PROCESS_COMPRESSIBILITY	60	Process compressibility is the compressibility of the process fluid at the process conditions of pressure and temperature. This value is used to calculate the PROCESS_DENSITY_RATIO and is not limit checked.
PROCESS_DENSITY	49	The configured density of the process fluid is used to calculate flow when mass units are selected.
PROCESS_DENSITY_RATIO	61	This parameter is the process density ratio used in the conversion to standard cubic feet and normal cubic meters. The ratio can either be entered directly or computed from configured base and process conditions. If entered directly, the PROCESS_PRESSURE parameter will change so that the PROCESS_DENSITY_RATIO computed value is the same as the entered value.
PROCESS_DENSITY_UNITS	50	The engineering units of PROCESS_DENSITY: 1097 = kilograms per cubic meter 1107 = pounds per cubic foot
PROCESS_PRESSURE	58	Process pressure is the operating pressure of the process fluid upon which the PROCESS_DENSITY_RATIO is calculated.
PROCESS_PRESSURE_UNITS	59	The engineering units of process pressure: 1137 = bar (absolute) 1142 = pounds per square inch (absolute) 1545 = Megapascals (absolute) 1547 = Kilopascals (absolute) 1557 = Kilograms per square centimeter (absolute)

Parameter	Index Number	Definition
PROCESS_TEMP_UNITS	52	The engineering units of process temperature: 1001 = °C 1002 = °F
PROCESS_TEMPERATURE	51	Process temperature is the configured temperature of the process fluid, in units of °C or °F. This parameter is used to compensate the K-factor for meter body expansion due to temperature. It is also used to calculate the PROCESS_DENSITY_RATIO.
REQ_PROC_DENSITY	48	This read-only parameter indicates the minimum required process density for proper flow measurement. It is based on the current configuration of the Low Flow Cutoff, Low Pass Filter, and Trigger Level parameters.
SECONDARY_VALUE	28	This parameter represents the secondary value related to the sensor (e.g., Vortex Shedding Frequency).
SECONDARY_VALUE_UNIT	29	The engineering units to be used with SECONDARY_VALUE: 1077 = Hz.
SENSOR_CAL_DATE	25	Sensor call date is the last date on which the calibration was performed.
SENSOR_CAL_LOC	24	This parameter specifies the location of the last sensor calibration.
SENSOR_CAL_METHOD	23	The last method used to calibrate the device (e.g., factory calibration or user specific): 103 = factory trim standard calibration
SENSOR_CAL_WHO	26	This parameter specifies the name of the person responsible for the last sensor calibration.
SENSOR_RANGE	21	Sensor range specifies the high and low range limit values, the engineering units code, and the number of digits to the right of the decimal point for the sensor. These values represent the nominal high and low range values for the sensor.
SENSOR_SN	22	SENSOR_SN is the serial number of the sensor.
SENSOR_TYPE	20	The type of sensor on input #1: 112 = Vortex
SERVICE_TYPE	35	Service type is the type of fluid being measured, either gas/steam or liquid. Changing service type will set the following to default values: PV Range 100% Value PV Range 0% Value Sensor Range 100% Value Low-Pass Code Low-Flow Cutoff Trigger level Liquid = 0, Gas/Steam = 1
SHEDDING_FREQ_AT_URV	68	This read-only parameter represents the Vortex Shedding Frequency required to generate a flow at 100% of the PV range. It is provided as an aid to the operator simulating flow with an external signal generator.
SIGNAL_STRENGTH	47	This parameter represents the relative sensor signal strength. A properly configured transmitter should have a signal strength value of 4 or greater for all flow rates greater than the low-flow cutoff point.
SIMULATION_CONTROL	66	This parameter is used to control transducer block flow simulation. Simulation can be disabled, enabled using an internal signal generator or enabled for use with an externally-conencted signal generator. Acceptable values are: Sim Disabled: Simulation is disabled, normal flow measurement is enabled. Sim-Internal Generator: Simulation is enabled using the internal generator. Sim-External Generator: Simulation is enabled using the external generator.
SIMULATION_HIGH_POINT	63	When flow simulation is enabled in the transducer block, this will configure the high point when the signal is ramping up and down. If equal to SIMULATION_LOW_POINT, a constant value will be simulated.
SIMULATION_LOW_POINT	64	When flow simulation is enabled in the transducer block, this will configure the low point when the signal is ramping up and down. If equal to SIMULATION_HIGH_POINT, a constant value will be simulated.
SIMULATION_RAMP_PERIOD	65	When flow simulation is enabled, this will configure the time for the signal to ramp from low to high, and from high to low. Units are in seconds.

Parameter	Index Number	Definition
SIMULATION_UNITS	62	This defines the units used to interpret the Simulation High and Low points. Acceptable values are: 1 = PV Engineering Units: Values are in currently configured engineering units. 2 = PV Percent of Range: Values are a percent of PV Range.
ST_REV	1	This parameter represents the revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
STRATEGY	3	The strategy field can be used to identify groupings of blocks. These data are not checked or processed by the block.
TAG_DESC	2	This parameter specifies the user description of the intended application of the block.
TRANSDUCER_DIRECTORY	9	The transducer directory specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	10	The transducer type identifies the transducer that follows.
TRIGGER_LEVEL	46	This parameter is an index that represents a minimum vortex shedding cycle amplitude after filtering. It has a value from 0 to 15, with a default value of 4. Increasing the value will raise the trigger level, requiring a greater sensor signal but decreasing susceptibility to noise. Decreasing the value will lower the trigger level, requiring a lower sensor signal but increasing susceptibility to noise.
UPDATE_EVT	7	This alert is generated by any change to the static data.
WETTED_MATERIAL	37	Construction materials of those items in contact with the process: 2 = 316 SST 3 = Hastelloy C® Each material has a different coefficient of expansion. Wetted material is used as an input to the compensated K-factor calculation.
XD_ERROR	11	XD_ERROR is a transducer block alarm subcode.

Block/Transducer Errors

The following conditions are reported in the BLOCK_ERR and XD_ERROR parameters. Conditions in *italics* are inactive for the transducer block and are given here only for your reference.

TABLE 4-2. BLOCK_ERR Conditions.

Condition Number	Condition Name and Description
0	*Other*
1	*Block Configuration Error*
2	*Link Configuration Error*
3	**Simulate Active**
4	*Local Override*
5	*Device Fault State Set*
6	**Device Needs Maintenance Soon**
7	**Input Failure/Process Variable Has Bad Status**
8	*Output Failure*
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*
13	**Device Needs Maintenance Now**
14	**Power Up:** The device was just powered-up.

TABLE 4-3. XD_ERR Conditions.

Condition Number	Condition Name and Description
15	**Out of Service:** The actual mode is out of service.
16	**Unspecified error:** An unidentified error occurred.
17	**General Error**: A general error that cannot be specified below occurred.
18	**Calibration Error**: An error occurred during calibration of the device, or a calibration error was detected during normal operations.
19	**Configuration Error**: An error occurred during configuration of the device, or a configuration error was detected during normal operations.
20	**Electronics Failure**: An electrical component failed.
21	**Mechanical Failure**: A mechanical component failed.
22	**I/O Failure**: An I/O failure occurred.
23	**Data Integrity Error**: Data stored in the device are no longer valid due to a nonvolatile memory checksum failure, a data verify after write failure, etc.
24	**Software Error**: The software has detected an error due to an improper interrupt service routine, an arithmetic overflow, a watchdog time-out, etc.
25	**Algorithm Error:** The algorithm used in the transducer block produced an error due to overflow, data reasonableness failure, etc.

Diagnostics

In addition to the BLOCK_ERR and XD_ERROR parameters, more detailed information on the measurement status can be obtained via TB_ELECTRONICS_STATUS. Table 4-4 lists the potential errors and the possible corrective actions for the given values. The corrective actions are in order of increasing system level compromises. Reset the transmitter and then, if the error persists, try the steps in Table 4-4. Start with the first corrective action and then try the second.

TABLE 4-4. TB_ELECTRONICS_STATUS Descriptions and Corrective Actions.

Value	Name and Description	Corrective Actions
0x00000002	SW_DETECTED_ERR: The device software has detected a software (typically math) error.	Restart the processor. If condition persists, send to the service center.
0x00000004	COPROCESSOR_ERR: The coprocessor has detected a math or instruction error.	Restart the processor. If condition persists, send to the service center.
0x00000008	ASIC_NOT_RESPONDING: The transducer has detected an A/D (analog-to-digital) ASIC (application-specific integrated circuit) general failure.	Restart the processor. If condition persists, send to the service center.
0x00000010	INTERRUPT_ERROR: The transducer block has detected that the coprocessor ASIC has stopped interrupting for service.	Restart the processor. If condition persists, send to the service center.
0x00000020	COPROC_RAM_ERR: The coprocessor has detected a RAM error at startup.	Restart the processor. If condition persists, send to the service center.
0x00000040	COPROC_ROM_ERR: The coprocessor has detected a ROM error at startup.	Restart the processor. If condition persists, send to the service center.
0x00000080	UPDATE_MISSED: The transducer has detected that a flow update from the coprocessor was missed.	If condition persists, send to the service center.
0x00000100	TRIGGER_OVERRANGE: The transducer has detected that the configuration for the filter trigger level is out of range.	Verify the filter trigger level configuration. If condition persists, send to the service center.
0x00000200	LOW_PASS_OVERRANGE: The transducer has detected that the configuration for the low pass filter is out of range.	Verify the low-pass filter configuration. If condition persists, send to the service center.
0x00000400	LOW_FLOW_OVERRANGE: The transducer has detected that the configuration for the low-flow cutoff is out of range.	Verify the low-flow cutoff configuration. If condition persists, send to the service center.
0x00000800	SD2_COMM_ERR: There has been a communications error detected in on-board messaging.	Re-start the processor. If condition persists, send to the service center.
0x04000000	FLOW_SIGNAL_INJECT: The transducer block is receiving its flow signal from an external signal generator.	Informational only.
0x08000000	FLOW_EMULATION_MODE: The transducer block is receiving its flow signal from the internal signal generator.	Informational only.
0x10000000	SENSOR_OVERRANGE: The transducer has detected a flow level that exceeds the upper sensor range. The status associated with the primary value (PV) and secondary value (SV) should also be BAD.	Reduce flow to prevent damage to the sensor.
0x20000000	PV_OVERRANGE: The transducer has detected a flow level that exceeds the PV upper range. The status associated with the PV and SV should also be UNCERTAIN. The flow is still measurable, but accuracy is not guaranteed.	Reduce flow below the PV upper range value.
0x40000000	IN_LOW_FLOW_CUTOFF: The transducer has detected that the flow has dropped below the configured low-flow cutoff value. The reported flow value will now damp to zero.	Informational only

Alarm Detection

Alarms are not generated by the transducer block. By correctly handling the status of the channel values, the down stream block (AI) will generate the necessary alarms for the measurement. The error that generated the alarm can be determined by looking at BLOCK_ERR and XD_ERROR.

Status Handling

Normally, the status of the output channels reflects the status of the measurement value, the operating condition of the measurement electronics card, and any active alarm condition. In Auto mode, OUT reflects the value and status quality of the output channels.

Troubleshooting

Refer to Table 4-5 to troubleshoot any problems that you encounter.

TABLE 4-5. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode will not leave out of service (OOS)	Target mode not set	Set target mode to something other than OOS.
	Resource block	The actual mode of the resource block is OOS. See Section 5: Resource Block “Troubleshooting” on page 5-5 for corrective action.
PV or SV is BAD.	Measurement	See “Diagnostics” on page 4-9. Flow is above SENSOR_RANGE.EU100.
PV or SV is UNCERTAIN.	Measurement	Flow is above PRIMARY_VALUE_RANGE.EU100 or flow is being simulated in the transducer block.

FLOW UNITS

The **flow units** are configured in the AI block. If Standard or Normal flow units are selected, the density ratio must be entered in the transducer block in order for the conversion to take place. If mass units are selected, the process density must be entered.

Standard/Normal Flow Units

The Model 8800C Flowmeter allows you to measure **standard or normal flow units** (SCFM, SCFH, NCMM, NCMH, NCMD). Configure the software in one of two ways:

1. Enter the density ratio to convert from actual flow rate to standard flow rate.
2. Enter the process and base conditions. (The Model 8800C Flowmeter electronics will then calculate the density ratio for you.)

See Density Ratio and Process and Base Conditions below for definitions.

NOTE
Be careful to calculate and enter the correct conversion factor. Standard flow is calculated with the conversion factor you enter. Any error in the factor entered will result in an error in the standard flow measurement. If pressure and temperature change over time, use actual volumetric flow units. The Model 8800C flowmeter does not compensate for changing temperature and pressure.

TRANSDUCER BLOCK

The transducer block contains the actual flow measurement data. The data include information about sensor type, engineering units, digital filter settings, damping, and diagnostics.

Process Variables (PV)

PV Value

PV Value is the actual measured flow rate in the line. On the bench, the value should be zero. Check the units of the value to make sure they are configured correctly. The unit configuration is contained in the AI block.

Sensor Serial Number

This parameter can be entered by the user to be the serial number of the unit or any other number they would like to insert.

Sensor Range

The **Sensor Range** is the entire flow range of the vortex meter. This includes the range that is out of the accuracy specification. If the range is between the PV Range and the Sensor Range, the status of the value is UNCERTAIN. If the Sensor Range is exceeded, the status goes to BAD and OUT OF SERVICE.

PV Range

The **PV Range** is the range of the Model 8800C that can be met with stated accuracy.

Basic Setup

Pipe I.D.

The **Pipe I.D.** (inside diameter) of the pipe adjacent to the flowmeter (mating pipe) can cause entrance effects that may alter flowmeter readings. You must specify the exact inside diameter of the pipe to correct for these effects. Enter the appropriate value for this variable.

Service Type

The flowmeter can be used for liquid or gas/steam applications, but it must be configured specifically for the application. If the flowmeter is not configured for the proper service type, readings will be inaccurate. Select the proper service type for your application:

- Liquid
- Gas/Steam

Process Temperature

Process Temperature and Temperature Units are needed for the electronics to compensate for thermal expansion of the flowmeter as the process temperature differs from the reference temperature. Process temperature is the temperature of the liquid or gas/steam in the line during flowmeter operation.

Process Density

Process Density and Density Units are required only if you have designated mass units for your flow rate units. It is required for the conversion from volumetric units to mass units. If you select volumetric units, process density is not required. For example, if you have set flow units to kg/sec rather than gal/sec, a density is required to convert the measured volumetric flow into the desired mass flow.

Damping

Damping changes the response time of the flowmeter to smooth variations in output readings caused by rapid changes in input. The default damping is 2.0 seconds. This can be reset to any value between 0.2 and 255 seconds.

Flow Units

Density Ratio

Density Ratio is used to convert the actual volumetric flow to standard/normal volumetric flow rates based on the following equations:

$$\text{Conversion factor} = \frac{\text{density at actual (flowing) conditions}}{\text{density at standard (base) conditions}}$$

$$\text{Conversion factor} = \frac{T_b \times P_f \times Z_b}{T_f \times P_b \times Z_f}$$

This value must be entered if using Standard or Normal units (SCFM, SCFH, NCMM, NCMH, NCMD). These units are configured in the AI block. The density ratio can also be calculated by entering the process and base conditions as described below (The Model 8800C electronics will then calculate the density ratio for you.)

Process Conditions

Used to calculate the density ratio. Refer to the equation listed under Density Ratio.

Process Temperature

Process Temperature is the absolute temperature T_f at actual (flowing) conditions in degrees Rankine or Kelvin. The Model 8800C electronics will convert from degrees Fahrenheit or degrees Celsius to degrees Rankine or Kelvin respectively.

Process Pressure

Process Pressure is the absolute pressure P_f at actual (flowing) conditions in psia or KPa absolute. The Model 8800C will convert from the pressures in absolute for the calculation.

Process Compressibility

Process Compressibility is the compressibility Z_f at actual (flowing) conditions (dimensionless).

Base Conditions

Base Conditions is used to calculate the density ratio. Refer to the equation listed under Density Ratio.

Base Temperature

Base Temperature is the absolute temperature T_b at standard (base) conditions in degrees Rankine or Kelvin. The Model 8800C electronics will convert from degrees Fahrenheit or degrees Celsius to degrees Rankine or Kelvin respectively.

Base Pressure

Base Pressure is the absolute pressure P_b at standard (base) conditions in psia or KPa absolute. The Model 8800C will convert from the pressures in absolute for the calculation.

Base Compressibility

Base Compressibility is the compressibility Z_b at standard (base) conditions (dimensionless).

Sensor

Pipe I.D.

The **Pipe I.D.** (inside diameter) of the pipe adjacent to the flowmeter (mating pipe) can cause entrance effects that may alter flowmeter readings. Specify the exact inside diameter of the pipe to correct for these effects. Enter the appropriate value for this variable.

Service Type

The flowmeter can be used for liquid or gas/steam applications, but it must be configured specifically for the application. If the flowmeter is not configured for the proper service type, readings will be inaccurate. Select the proper Service Type for your application:

- Liquid
- Gas/Steam

Reference K-Factor

The **Reference K-factor** is factory set according to the actual K-factor for the application. It should only be changed if you replace parts of the flowmeter. It is located on the meter body tag.

Installation Effects

Installation Effects enables you to compensate the flowmeter for installation effects. See reference graphs located in Technical Data Sheet (document number 00816-0100-3250) for the percent of K-factor shift based on entrance effects of upstream disturbances. This value can be set between +1.5% to -1.5%.

Compensated K-factor

The **Compensated K-factor** is based on the reference K-factor as compensated for the given process temperature, wetted materials, body number and pipe I.D. Compensated K-factor is an informational variable that is calculated by the electronics of your flowmeter.

Meter Body Number

The **Meter Body Number** is a factory set configuration variable that stores the body number of your particular flowmeter and the type of construction. The meter body number is found to the right of the body number on the meter body tag, which is attached to the support tube of the meter body.

The format of this variable is a number followed by an alpha numeric character. The number designates the body number. The alpha numeric character designates the meter body type. There are three options for the alpha numeric character:

1. None – Indicates welded meter construction
2. A – Indicates welded meter construction
3. B – Indicates cast construction

Process Temperature

Process Temperature and Temperature Units are needed for the electronics to compensate for thermal expansion of the flowmeter as the process temperature differs from the reference temperature. Process temperature is the temperature of the liquid or gas/steam in the line during flowmeter operation.

Wetted Material

Wetted Material is a factory set configuration that reflects the construction of your flowmeter:

- 316 SST
- Hastelloy-C®

Flange Type

Flange Type enables you to specify the type of flange on the flowmeter for later reference. This variable is preset at the factory but can be changed if necessary.

- Wafer
- ASME B16.5 (ANSI) 150
- ASME B16.5 (ANSI) 300
- ASME B16.5 (ANSI) 600
- ASME B16.5 (ANSI) 900
- PN 10
- PN 16
- PN 40
- PN 64
- PN 100
- JIS 10k
- JIS 20k
- JIS 40k
- Special

Filtering

Flow Rate Value

Flow Rate Value is the actual measured flow rate in the line. On the bench, the value should be zero. Check the units of the value to make sure they are configured correctly. The unit configuration is contained in the AI block.

Shedding Frequency

Shedding Frequency measures the frequency of vortex pulses around the shedder bar.

Sensor Signal Strength

Sensor Signal Strength is a variable that indicates the flow signal strength. This value indicates if there is enough flow signal strength for the meter to work properly. For accurate flow measurement, the value should be greater than 4.0. Values greater than 4.0 will allow increased filtering for noisy applications. Values less than 4.0 may indicate applications with very low densities and/or applications with excessive filtering.

Lowpass Corner

The **Lowpass Corner** filter set s the low-pass corner frequency to minimize the effects of high frequency noise. It is factory set based on line size and service type. Adjustments may be required only if there are problems.

Low Flow Cut

The **Low Flow Cut** enables adjustment of the filter for noise at no flow. It is set at the factory to handle most applications, but certain applications may require adjustment either to expand measurability or to reduce noise. It also includes a dead band such that once flow goes below the cutoff value, output does not return to the normal flow range until flow goes above the dead band.

Filter Trigger Level

Filter Trigger Level is configured to reject noise within the flow range while allowing normal amplitude variation of the vortex signal. Signals of amplitude lower than the Filter Trigger Level setting are filtered out. The factory setting optimizes nose rejection in most applications.

Filter Auto Adjust

The **Filter Auto Adjust** is a function that can be used to optimize the range of the flowmeter based on the density of the fluid. The electronics uses process density to calculate the minimum measurable flow rate, while retaining at least a 4.0 signal strength value.

Required Process Density

The **Required Process Density** is calculated from the filter settings. It is the process density that is required to obtain an adequate sensor signal.

Display

The **Local Display Function** on the Model 8800C selects which variables are shown on the optional (M5) local display. Choose from the following variables:

- Flow
- Percent of Range
- Shedding Frequency

Modes

Target Mode

The transducer block supports two modes of operation as defined by the MODE_BLK Parameter:

- **Automatic (Auto)**—The channel outputs reflect the analog input measurement.
- **Out of Service (O/S)**—The block is not processed. Channel outputs are not updated and the status is set to **Bad: Out of Service** for each channel. The BLOCK_ERR parameter shows **Out of Service**. In this mode, you can make changes to all configurable parameters. The target mode of a block may be restricted to one or more of the supported modes.

Flow Simulation

Flow Simulation enables you to check the electronics functionality. This can be verified with the Flow Simulation Internal and Flow Simulation External method. See Section 9: Electronics Verification for detailed instructions on how to operate.

Flow

Flow shows the flow value in current engineering units for the flow simulation.

Shedding Frequency (Secondary Value)

Shedding Frequency (Secondary Value) shows the shedding frequency for the flow simulation.

Shedding Frequency at URV

Shedding Frequency at URV gives the shedding frequency corresponding to your upper range value.

Simulation Control

Simulation Control allows you to configure your flow simulation using internal or external simulation.

Sim Disable

Sim Disable allows you to exit the flow simulation mode (internal or external) and return you to normal operation mode.

Sim - Internal Generator

The **Sim - Internal Generator** function will automatically disconnect the sensor and enable you to select the configuration of the internal simulate (fixed or varied).

Sim - External Generator

Sim - External Generator flow allows you to disconnect the sensor electronically so an external frequency source can be used.

Simulation Units

The flow simulation can be performed as either a percent of range or flow rate in current engineering units.

Simulation Ramp Period

The **Simulation Ramp** period can be entered in seconds from a minimum of 0.5 seconds to a maximum of 32,000 seconds.

Section 5

Resource Block

OVERVIEW

Section 5 contains information on the Model 8800C Flowmeter resource block. Descriptions of all resource block parameters, errors, and diagnostics are included. Also the modes, alarm detection, status handling, Virtual Communication Relationships (VCRs), and troubleshooting are discussed.

Definition

The resource block defines the physical resources of the device, including type of measurement, memory, etc. The resource block also handles functionality, such as shed times, that is common across multiple blocks. The block has no linkable inputs or outputs and it performs memory-level diagnostics.

PARAMETERS AND DESCRIPTIONS

Table 5-1 lists all of the configurable parameters of the resource block, including the descriptions and index numbers for each parameter.

TABLE 5-1. Resource Block Parameters.

Parameter	Index Number	Description
ACK_OPTION	38	ACK_OPTION is a selection of whether alarms associated with the function block will be automatically acknowledged.
ALARM_SUM	37	This parameter shows the current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block. In the Model 8800C Flowmeter, the two resource block alarms are write alarm and block alarm.
ALERT_KEY	04	ALERT_KEY shows the identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
BLOCK_ALM	36	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the active status in the status parameter. As soon as the unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the active status, if the subcode has changed.
BLOCK_ERR	06	This parameter reflects the error status of the hardware or software components associated with a block. It is a bit string, so multiple errors may be shown.
CONFIRM_TIME	33	This parameter represents the minimum time between retries of alert reports.
MESSAGE_DATE	52	MESSAGE_DATE is the date associated with the MESSAGE_TEXT parameter.
SUMMARY_STATUS	51	This parameter represents an enumerated value of repair analysis.
CYCLE_SEL	20	This parameter is used to select the block execution method for this resource. The Model 8800C Flowmeter supports the following executions: Scheduled: Blocks are only executed based on the schedule in FB_START_LIST. Block Execution: A block may be executed by linking to another block's completion.
CYCLE_TYPE	19	This parameter identifies the block execution methods available for this resource.
DD_RESOURCE	09	This string identifies the tag of the resource that contains the device description for this resource.
DD_REV	13	DD_REV is a revision of the DD associated with the resource—used by an interface device to locate the DD file for the resource.
DEFINE_WRITE_LOCK	55	DEFINE_WRITE_LOCK is the enumerated value describing the implementation of the WRITE_LOCK.
DETAILED_STATUS	50	This parameter represents the additional status bit string.

Parameter	Index Number	Description
DEV_REV	12	DEV_REV specifies the manufacturer revision number associated with the resource—used by an interface device to locate the DD file for the resource.
DEV_TYPE	11	DEV_TYPE specifies the manufacturer's model number associated with the resource—used by interface devices to locate the DD file for the resource. 8800C Flowmeter.
DOWNLOAD_MODE	62	DOWNLOAD_MODE gives access to the boot block code for over-the-wire downloads.
FEATURES	17	This parameter is used to show supported resource block options.
FEATURES_SEL	18	This parameter is used to show selected resource block options. The Model 8800C Flowmeter supports the following options: Unicode: Tells host to use unicode for string values Reports: Enables alarms; must be set for alarming to work Software Lock: Software write locking enabled but not active; WRITE_LOCK must be set to activate. Hardware Lock: Hardware write locking enabled but not active; WRITE_LOCK follows the status of the security switch.
FINAL_ASSEMBLY_NUMBER	49	FINAL_ASSEMBLY_NUMBER is used for identification purposes and is associated with the overall field device.
FREE_TIME	25	FREE_TIME is the percent of the block processing time that is free to process additional blocks.
FREE_SPACE	24	FREE_SPACE is the percent of memory available for further configuration (zero in a preconfigured device).
GRANT_DENY	14	This parameter represents options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block (not used by device).
HARD_TYPES	15	This parameter represents the types of hardware available as channel numbers. For the Model 8800C Flowmeter, this parameter is limited to scalar (i.e., analog) inputs.
HARDWARE_REVISION	47	This parameter represents hardware revision of the hardware that has the resource block in it.
LICENSE_STRING	42	LICENSE_STRING will determine which of the downloaded function blocks are active.
LIM_NOTIFY	32	This parameter represents the maximum number of unconfirmed alert notify messages allowed.
MANUFAC_ID	10	MANUFAC_ID is the manufacturer identification number used by an interface device to locate the DD file for the resource (001151 for Rosemount).
MAX_NOTIFY	31	MAX_NOTIFY is the maximum number of unconfirmed alert notify messages possible.
MEMORY_SIZE	22	This parameter represents the available configuration memory in the empty resource. Check MEMORY_SIZE before attempting a download.
MESSAGE_TEXT	53	MESSAGE_TEXT is used to indicate changes made by the user to the device's installation, configuration, or calibration.
MIN_CYCLE_T	21	MIN_CYCLE_T represents the time duration of the shortest cycle interval of which the resource is capable.
MODE_BLK	05	The actual, target, permitted, and normal modes of the block: Target: The mode to "go to" Actual: The mode the "block is currently in" Permitted: Allowed modes that the target mode may take on Normal: Most common mode for the actual model
NV_CYCLE_T	23	NV_CYCLE_T represents the interval between writing copies of NV parameters to nonvolatile memory (zero means never).
OUTPUT_BOARD_SN	48	OUTPUT_BOARD_SN is the output board serial number.
SELF_TEST	54	SELF_TEST instructs the resource block to perform a self-test.
PRIVATE_LABEL_DISTRIBUTOR	41	PRIVATE_LABEL_DISTRIBUTOR references the company that is responsible for the distribution of this field device to customers.
RESTART	16	RESTART allows a manual restart to be initiated. Several degrees of restart are possible: 1 Run: Nominal state when not restarting 2 Restart resource: Not used 3 Restart with defaults: Set parameters to default values (see START_WITH_DEFAULTS below for which parameters are set). 4 Restart processor: Does a warm start of CPU
RS_STATE	07	RS_STATE represents the state of the function block application state machine.

Parameter	Index Number	Description
SAVE_CONFIG_BLOCKS	57	This parameter represents the number of EEPROM blocks that have been modified since the last burn. This value will count down to zero when the configuration is saved.
SAVE_CONFIG_NOW	56	SAVE_CONFIG_NOW controls saving of configuration in EEPROM.
SECURITY_JUMPER	60	This parameter represents the status of security jumper/switch.
SHED_RCAS	26	SHED_RCAS represents the time duration at which to give up on computer writes to function block RCas locations.
SHED_ROUT	27	SHED_ROUT represents the time duration at which to give up on computer writes to function block ROut locations.
SIMULATE_STATE	61	This parameter represents the state of the simulate function.
SIMULATE_JUMPER	59	This parameter represents the status of the simulate jumper/switch.
SOFTWARE_REVISION_ALL	46	SOFTWARE_REVISION_ALL is the software revision string containing the following fields: major revision, minor revision, build, time of build, day of week of build, month of build, day of month of build, year of build, initials of builder.
SOFTWARE_REVISION_BUILD	45	SOFTWARE_REVISION_BUILD is the build of software that the resource block was created with.
SOFTWARE_REVISION_MAJOR	43	SOFTWARE_REVISION_MAJOR represents a major revision of software that the resource block was created with.
SOFTWARE_REVISION_MINOR	44	This parameter represents a minor revision of software that the resource block was created with.
START_WITH_DEFAULTS	58	START_WITH_DEFAULTS controls what defaults are used at power-up.
STRATEGY	03	The strategy field can be used to identify grouping of blocks. These data are not checked or processed by the block.
ST_REV	01	ST_REV is the revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	02	TAG_DESC is the user description of the intended application of the block.
TEST_RW	08	TEST_RW is a parameter for a host to use to test reading and writing (not used by the device at all).
UPDATE_EVT	35	This alert is generated by any change to the static data.
WRITE_ALM	40	This alert is generated if the write lock parameter is cleared.
WRITE_LOCK	34	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated.
WRITE_PRI	39	This parameter specifies the priority of the alarm generated by clearing the write lock.

Block Errors

Table 5-2 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the resource block and are given here only for your reference.

TABLE 5-2. BLOCK_ERR Conditions.

Condition Number	Condition Name and Description
0	*Other*
1	**Block Configuration Error:** A feature in FEATURES_SEL is set that is not supported by FEATURES or an execution cycle in CYCLE_SEL is set that is not supported by CYCLE_TYPE.
2	**Link Configuration Error:** A link used in one of the function blocks is improperly configured.
3	**Simulate Active:** The simulation jumper is in place. Simulate active is not an indication that the I/O blocks are using simulated data.
4	*Local Override*
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	*Input failure/process variable has bad status*
8	*Output Failure: The output is bad based primarily upon a bad input.*
9	**Memory Failure:** A memory failure has occurred in FLASH, RAM, or EEROM memory.
10	**Lost Static Data:** Static data that are stored in nonvolatile memory have been lost.
11	**Lost NV Data**: Nonvolatile data that are stored in nonvolatile memory have been lost.
12	*Readback Check Failed*
13	**Device Needs Maintenance Now**
14	**Power Up:** The device was just powered-up.
15	**Out of Service:** The actual mode is out of service.

Modes

The resource block supports two modes of operation as defined by the MODE_BLK parameter:

- **Automatic (Auto)** The block is processing its normal background memory checks.
- **Out of Service (O/S)** The block is not processing its tasks. When the resource block is in O/S, all blocks within the resource (device) are forced into O/S. The BLOCK_ERR parameter shows OUT OF SERVICE. In this mode, you can make changes to all configurable parameters. The target mode of a block may be restricted to one or more of the supported modes.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the resource block are defined above (see Table 5-2).

A write alarm is generated whenever the WRITE_LOCK parameter is cleared. The priority of the write alarm is set in the following parameter:

- WRITE_PRI

Alarms are grouped into five levels of priority:

TABLE 5-3. Alarm Priority.

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3–7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8–15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

There are no status parameters associated with the resource block.

VCR

The number of configurable VCRs is 8. The parameter is not contained or viewable within the resource block, but it does apply to all blocks.

Troubleshooting

Refer to Table 5-4 to troubleshoot any problems that you encounter.

TABLE 5-4. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS.	Target mode not set	Set target mode to something other than OOS.
	Memory failure	BLOCK_ERR will show the lost NV Data or Lost Static Data bit set. Restart the device by setting RESTART to processor. If the block error does not clear, call the factory.
Block alarms will not work.	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status options	STATUS_OPTS has Propagate Fault Forward bit set, which should be cleared to cause an alarm to occur.

Section 6

Maintenance and Troubleshooting

Table 6-1 provides summarized troubleshooting suggestions for the most common problems that occur during operation. The symptoms of metering problems include:

- Flow in pipe but no transmitter output
- Flow in pipe with incorrect transmitter output
- Output with no actual flow

NOTE
The Model 8800C Flowmeter sensor is extremely reliable and should not have to be replaced. Please consult the factory before removing the sensor.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to insure the safety of the personnel performing the operations. Please refer to the following safety messages before performing any operations in this section.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

⚠WARNING

The sensor cavity could contain line pressure if an abnormal failure has occurred inside the meter body. Depressurize flow line before removing the sensor nut.

TROUBLESHOOTING TABLES

The most common problems experienced by users of the Model 8800C Flowmeter are listed in Table 6-1, along with potential causes of the problem and suggested corrective actions. See live if the problem you are experiencing is not listed here.

TABLE 6-1. Basic Troubleshooting—Model 8800C Vortex Flowmeter with FOUNDATION Fieldbus

Symptom	Corrective Action
Flow in Pipe, No Output	**Basics** • Check to make sure that the meter is installed with the arrow in the direction of flow. • Check and correct configuration parameters in this order: K-factor, service type, materials, units, process temperature, damping value, density, pipe diameter, LRV, URV, trigger level, low-flow cutoff. • Check sizing. Make sure flow is within measurable flow limits. • Refer to live. • See Section 9: Electronics Verification for electronics verification procedure. **Electronics** • Using sensor simulator, insert test signal. • Check configuration, LFC, trigger level, STD vs. actual flow. • Replace electronics. **Application Problems** • Calculate expected frequency (see Section 9: Electronics Verification). If actual frequency is the same, check configuration. • Check that application meets viscosity and specific gravity requirements for the line size. • Recalculate back pressure requirement. If necessary and possible, increase back pressure, flow rate, or operating pressure. **Sensor** • Check torque on sensor nut (32 ft-lb). • Inspect coaxial sensor cable for cracks. Replace if necessary. • Check that sensor impedance >10 Megaohms. Replace the sensor if necessary (see “Replacing the Sensor” on page 6-12). • Measure sensor capacitance at SMA connector (100–200pF).
Flow in Pipe, Incorrect Output	**Basics** • Check and correct configuration parameters in this order: K-factor, service type, materials, units, process temperature, damping value, density, pipe diameter, LRV, URV, trigger level, and low-flow cutoff. • Check sizing. Make sure flow is within measurable flow limits. • Refer to live. • See Section 9: Electronics Verification for electronics verification procedure. **Application Problems** • Calculate expected frequency. If actual frequency is the same, check configuration. • Check to make sure the meter is not installed backwards (if the arrow on the meter is pointing upstream, then the meter is installed backwards). Re-install the meter if necessary. • Check that application meets viscosity and specific gravity requirements for the line size. • Recalculate back pressure requirement. If necessary and possible, increase back pressure, flow rate, or operating pressure. • Check for gasket or other obstruction disturbing flow. Reinstall meter if necessary. • Check if pump pulsations are disturbing flow. Adjust signal processing parameters. **Vibration Problem** • Adjust signal processing parameters. • Rotate meter 90°. • Add support to the line near the meter to damp the vibration. When the vortex meter is set for gas or steam service and the vibration levels are greater than ½ g, the low-flow cutoff value (LFC) may need to be increased to eliminate undesirable output at no flow conditions. The level of LFC increase depends on the vibration level and meter size. LFC is unique for each application. When flow begins, the flow signal becomes much larger than the vibration signal and the meter will lock onto the flow signal and give an accurate flow output.

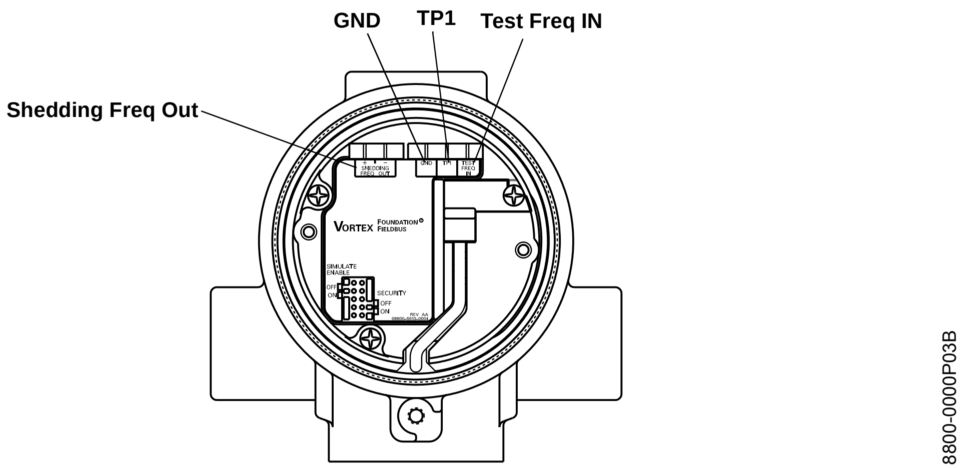
Symptom	Corrective Action
Flow in Pipe, Incorrect Output (continued)	**50/60 Hz Measurement** • May indicate electrical or magnetic interference; check the meter ground. • If the meter is located near a large motor or electric furnace, try different meter orientations to reduce the noise. Magnetic fields must be less than 5 gauss. • In remote-mount installations, try integral mount to see if the problem is corrected. Measure ac voltage from the electronics housing to the SMA connector. The voltage must be <1Vrms. **Sensor** • The sensor should resist removal because the interference fit has extremely tight tolerances. Repeated removal and installation of the sensor will loosen it. If the sensor is loose, replace the sensor. • Inspect and tighten the sensor connector if necessary. • Inspect the coaxial sensor cable for cracks. Replace it if necessary. • Check torque on the sensor nut (32 ft-lb). • Check that sensor impedance >10 Megaohms. Replace the sensor if necessary (see “Replacing the Sensor” on page 6-12). • Measure sensor capacitance at the SMA connector (100–200pF).

Output with No Actual Flow	**Basics**
	• Check and correct configuration parameters in this order: K-factor, service type, materials, units, process temperature, damping value, density, pipe diameter, LRV, URV, trigger level, low-flow cutoff.
	• Check sizing; make sure flow is within measurable flow limits.
	• Refer to live.
	Vibration Problem
	• Adjust signal processing parameters:
	  • *Adjust low-flow cutoff to higher flow rates (if the application allows). Move the low-flow cutoff up one notch and measure the process variable. Continue moving the low-flow cutoff until the problem is corrected or the flow range is too limited for the application.*
	  • *Adjust the trigger level up; the default trigger level is four. Adjust it one notch and measure the process variable. Continue moving the trigger level until the output reaches zero or the trigger level reaches a value of seven. Be sure to check the process variable with the process flowing once you are done adjusting the trigger level.*
	• Rotate the meter 90°.
	• Add support to the line near the meter to damp the vibration.
	50/60 Hz Measurement
	• May indicate electrical or magnetic interference; check the meter ground.
	• If the meter is located near a large motor or electric furnace, try different meter orientations to reduce the noise. Magnetic fields must be less than 5 gauss.
	• In remote mount installations, try integral mount to see if the problem is corrected. Measure ac voltage from the electronics housing to the SMA connector. The voltage must be <1Vrms.
	Application Problems
	• Check if the pump pulsations are disturbing flow. Adjust the signal processing parameters.
	• Add flow straightener.
	• Check all valves and make sure they are closed.

ADVANCED TROUBLESHOOTING

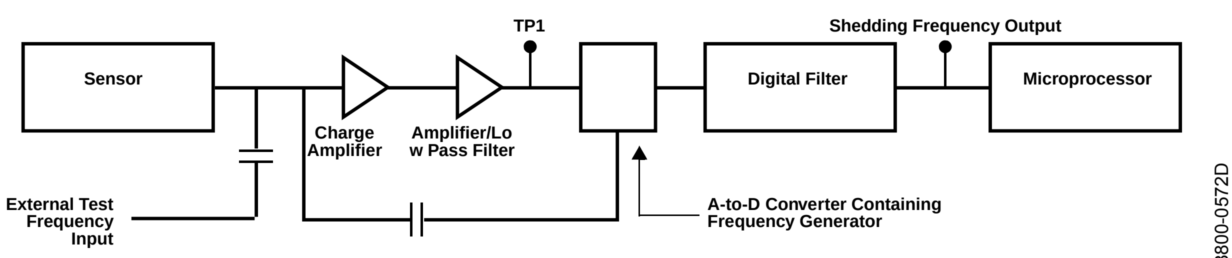
The Model 8800C electronics provides several advanced troubleshooting features. These features enhance your ability to look inside the electronics and can be helpful for troubleshooting inaccurate readings. As shown in Figure 6-1, there are several test points located on the electronics.

FIGURE 6-1.
Electronics Test Points.



A digital representation of the filtered sensor shedding frequency is available on the “SHEDDING FREQ OUT” pins shown in Figure 6-1. The electronics are capable of internally generating a flow signal that may be used to simulate a sensor signal to perform electronics verification with any FOUNDATION fieldbus-compliant host, such as the DeltaV system with AMS from Fisher-Rosemount. The simulated signal amplitude is based on the transmitter required minimum process density. The signal being simulated can be one of several profiles – a simulated signal of constant frequency or a simulated signal representative of a ramping flow rate. The electronics verification procedure is described in detail in Section 9: Electronics Verification. To verify the electronics, you can input a frequency on the “TEST FREQ IN” and “GND” pins to simulate flow via an external signal source such as a frequency generator. To analyze and/or troubleshoot the electronics, an oscilloscope (set for AC coupling) and a DeltaV with AMS interface are required. Figure 6-2 is a block diagram of the signal as it flows from the sensor to the microprocessor in the electronics.

FIGURE 6-2. Signal Flow.



TP1

TP1 is the vortex shedding signal after it has gone through the charge amplifier and low pass filter stages and into the input of the sigma delta A-to-D converter ASIC in the electronics. The signal strength at this point will be in the mV to Volt range.

TP1 is easily measured with standard equipment.

Figures 6-3, 6-4, and 6-5 show ideal (clean) waveforms and waveforms that may cause the output to be inaccurate. Please consult the factory if the waveform you detect is not similar in principle to these waveforms.

FIGURE 6-3. Clean Signals.

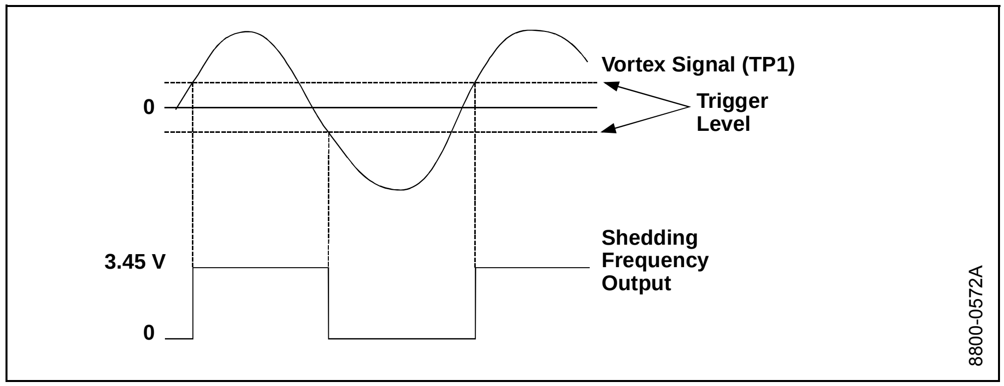


FIGURE 6-4. Noisy Signals.

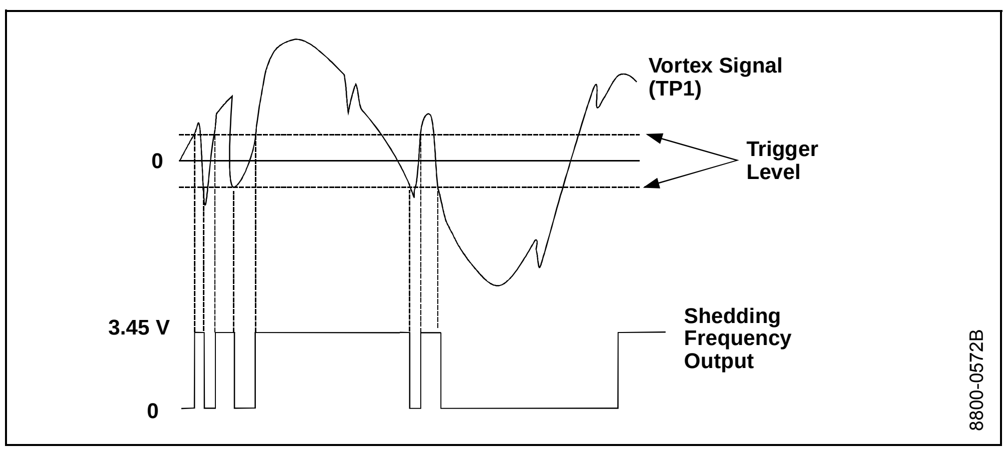
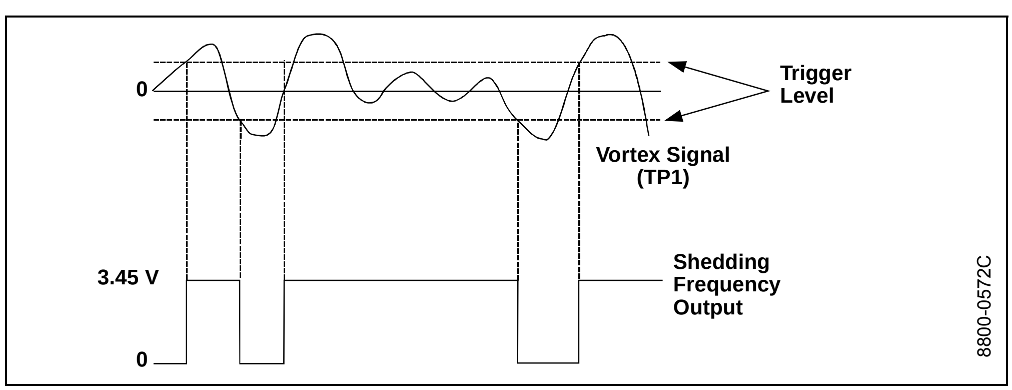


FIGURE 6-5. Improper Sizing/Filtering.



Shedding Frequency Out

Shedding frequency out is probably the easiest point to measure and interpret; it is the final waveform after all filtering has taken place. Shedding frequency out is the flow signal that is sent to the microprocessor to be processed into outputs. Check this point first, as it will allow you to see the final waveform (after filtering) before it goes to the microprocessor.

TABLE 6-2. Troubleshooting—
Shedding Frequency Out.

Symptom	Corrective Action
Clean Signals at TP1 and Shedding Frequency Out, But Incorrect Output	**Basics** • Check and correct configuration parameters in this order: K-factor, service type, materials, units, process temperature, damping value, density, density ratio, pipe diameter, LRV, URV, LP corner, trigger level, and low-flow cutoff. • Refer to live. • See Section 9: Electronics Verification for electronics verification procedure. • Refer to Table 6-1 for further troubleshooting.
No Pulse at Shedding Frequency Out	**Basics** • Check TP1. • Check electronics via flow Flow Simulation mode (see Section 9: Electronics Verification). • Check electronics with an external frequency generator. • Check that sensor impedance >10 Megaohms. Replace sensor if necessary. (See “Replacing the Sensor” on page 6-12.) • Measure sensor capacitance at SMA connector (100–200pF).
Noisy Signal at Shedding Frequency Out	**Basics** • Simulate signal with frequency generators or Flow Simulation mode (see Section 9: Electronics Verification). • Optimize filter (gas); increase filtering of low pass filter. • Consult the factory.
Missing Pulse at Shedding Frequency Out	**Basics** • Low back pressure • Viscosity too high • Density too low • Check the sensor. • Too much filtering; check the signal/trigger level rate.

HARDWARE MAINTENANCE

The Model 8800C Flowmeter has no moving parts and requires a minimum amount of scheduled maintenance. The transmitter features a modular design for easy maintenance. If you suspect a malfunction, check for an external cause before performing the diagnostics presented below.

The following procedures will help you disassemble and assemble the Model 8800C Flowmeter hardware if you have followed the troubleshooting guide earlier in this section of the manual and determined that hardware components need to be replaced.

NOTE
Failure of the Model 8800C Flowmeter housing, electronics, terminal block, LCD indicator, or entire assembly requires replacement with the Model 8800C Flowmeter housing, electronics, terminal block, and optional LCD indicator. The Model 8800C Flowmeter can be identified on the SST tag or by visually checking to see if the conduit entries are on the top of the housing. See "Replacing the Foundation Fieldbus Electronics Housing" on page 6-10 for further information.

NOTE
Use only the procedures and new parts specifically referenced in this manual. Unauthorized procedures or parts can affect product performance and the output signal used to control a process, and may render the instrument dangerous. Direct any questions concerning these procedures or parts to Rosemount Inc.

NOTE
Flowmeters should not be left in service once they have been determined to be inoperable.

NOTE
Process should be vented before the meter body is removed from service for disassembly.

See "Safety Messages" on page 6-1 for complete warning information.

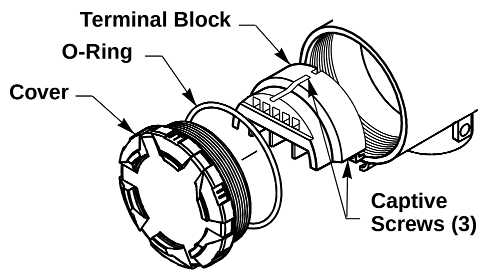
Replacing the FOUNDATION Fieldbus Terminal Block in the Housing

To replace the FOUNDATION fieldbus field terminal block in the housing, you will need a small, flat-head screwdriver. Use the following procedure to replace the terminal block in the housing of the Model 8800C Flowmeter.

Remove the Terminal Block

1. Turn off the electric power to the Model 8800C Flowmeter.
2. Unscrew the cover.

Figure 6-6. FOUNDATION Fieldbus Terminal Block Assembly.



3. Disconnect the wires from the field terminals. Be sure to secure them out of the way.
4. Loosen the captive screws.
5. Pull outward on the block to remove it from the housing.

Install the Terminal Block

1. Align the terminal block over the captive screw holes in the terminal block side of the electronics housing.
2. Slowly press the terminal block into place. Do not force the block into the housing. Check the screw alignment if it does not glide into place.
3. Tighten the three captive screws to anchor the terminal block.
4. Connect the wires to the appropriate field terminals.
5. Screw on and tighten the cover.

Replacing the FOUNDATION Fieldbus Electronics Boards

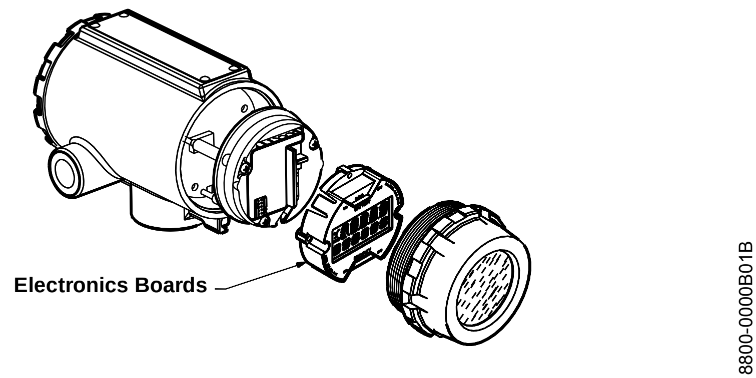
The Model 8800C Flowmeter FOUNDATION fieldbus electronics boards may need to be replaced if they have been damaged or otherwise become dysfunctional. Use the following procedures to replace electronics boards in the Model 8800C Flowmeter. You will need a small, flat-head screwdriver and a pliers.

NOTE
The electronics boards are electrostatically sensitive. Be sure to observe handling precautions for static-sensitive components.

Remove the Electronics Boards

1. Turn off the electric power to the Model 8800C Flowmeter.
2. Unscrew and remove the electronics board compartment cover. (Unscrew and remove the LCD cover if you have the LCD option.)

Figure 6-7. Electronics Board Assembly.



3. If the meter has the LCD indicator option, loosen the two screws. Remove the LCD and the connector from the electronics board.
4. Use a pliers to carefully remove the sensor cable clip from the electronics.
5. Loosen the three captive screws that anchor the electronics.
6. Use the two screw heads on the right- and left-hand sides of the board to slowly pull the electronics boards out of the housing.

See “Safety Messages” on page 6-1 for complete warning information.

Install the Electronics Boards

1. Verify that electric power to the Model 8800C Flowmeter is off.
2. Align the two electronics boards over the captive screw holes in the housing.
3. Slowly press the boards into place. Do not force the boards down. Check the screw alignment if they do not glide into place.
4. Tighten the captive screws to anchor the two electronics boards.
5. Reinsert jumpers into proper location.
6. Use extreme caution to insert sensor cable clip into the electronics board.
7. If the meter has the LCD option, insert the connector header into the LCD board.
8. Put the connector through the bezel on the electronics board set.
9. Carefully press the indicator onto the connector.
10. Tighten the two screws that retain the LCD indicator.
11. Insert the alarm and security jumpers in the correct location.
12. Replace the electronics board compartment cover.

Replacing the FOUNDATION Fieldbus Electronics Housing

The Model 8800C Flowmeter electronics housing can be replaced easily when necessary. Use the following procedure:

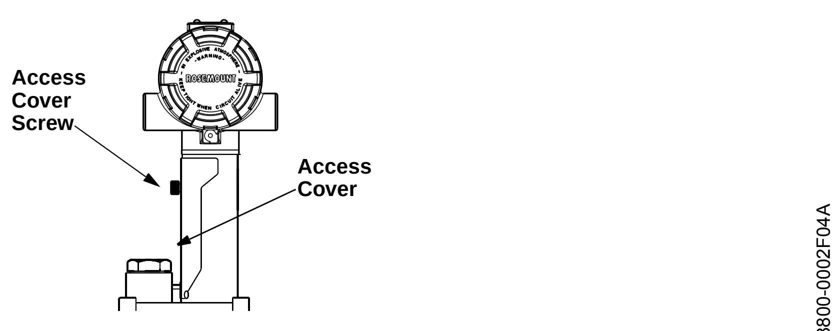
Tools Needed

- 5/32 in. (4 mm) hex wrench
- 5/16 in. open-end wrench
- Screwdriver to disconnect wires
- Tools to disconnect conduit

Remove the Electronics Housing

1. Turn off the electric power to the Model 8800C Flowmeter.
2. Disconnect the wires and conduit from the housing.
3. Loosen the screw on the access cover (on the support tube). See Figure 6-8.
4. Remove the access cover.

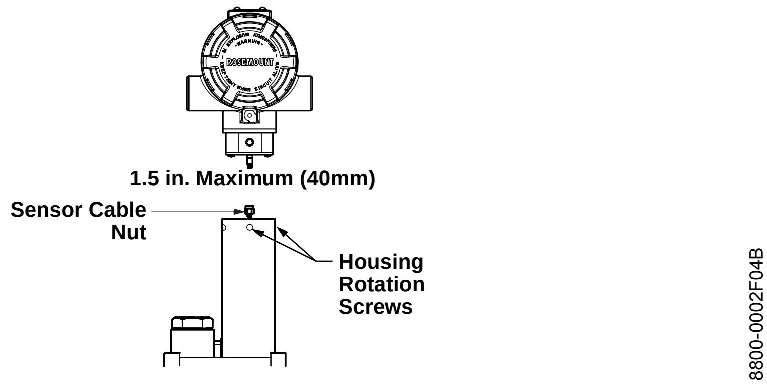
Figure 6-8. Electronics Housing Access Cover.



See “Safety Messages” on page 6-1 for complete warning information.

5. Use a hex wrench to loosen the housing rotation screws (at the base of the electronics housing) by turning the screws clockwise (inward) until they clear the bracket. See Figure 6-9.

Figure 6-9. Housing Rotation Screws.



6. Slowly pull the electronics housing no more than 1.5 in. from the top of the support tube.
7. Loosen the sensor cable nut from the housing with a 5/16 in. open-end wrench. See Figure 6-9.

NOTE

Lift the electronics housing until the sensor cable is disconnected. Do not pull the housing more than 1.5 in. (40 mm) from the top of the support tube. Damage to the sensor may occur if this sensor cable is stressed.

Install the FOUNDATION Fieldbus Electronics Housing

1. Verify that power to the Model 8800C Flowmeter is off.
2. Screw the sensor cable onto the base of the housing.
3. Tighten the sensor cable with a 5/16 in. open-end wrench.
4. Place the electronics housing into the top of the support tube.
5. Tighten the housing rotation screws with a hex wrench.
6. Place the access cover on the support tube.
7. Tighten the screw on the access cover.
8. Connect conduit and wires.
9. Apply power.

Replacing the Sensor

The sensor for the Model 8800C is a sensitive instrument that should not be removed unless there is a problem with it. If you must replace the sensor, follow these procedures closely. The Model 8800C Vortex Flowmeter sensor is extremely reliable, so it ordinarily does not need to be replaced. **Please consult the factory before removing the sensor.**

NOTES
Be sure to fully check all other troubleshooting possibilities before removing the sensor.

Do not remove the sensor unless it is determined that a problem exists with the sensor itself. The sensor may not fit on the post if it is removed and replaced more than two or three times, or replaced incorrectly.

Also, please note that the sensor is a complete assembly and cannot be further disassembled.

Tools Needed

- 5/32-inch (4 mm) hex wrench
- 5/16-inch open end wrench
- 7/16-inch open end wrench
- 3/4-inch open end wrench (for 3- and 4-inch [80 and 100 mm] SST wafers)
- 1 1/8-inch open end wrench (for all other models)
- Suction or compressed air device
- Small, soft bristle brush
- Cotton swabs
- Appropriate cleaning liquid: water or cleaning agent

There are two support tubes for the Model 8800C. The removable support tube is for wafer meters 1/2- through 4-inch (15 through 100 mm) and all flanged meters. The integral support tube is for 6- and 8-inch (150 and 200 mm) wafer meters. The procedure for replacing the sensor contains details for both the removable and integral support tubes.

Sensor Compatibility Guide

1. Determine the sensor serial number. The sensor serial number is located on the top of the sensor.
2. Verify meter body number designator as either “none”, “A”, or “B”. The body number is found on the meter body tag.
   Ex. 101467, 101467A, or 101467B.

   Meter body designators:
   none = welded body with sensor s/n < 30000.

   A = welded body with sensor s/n ≥ 300000

   B = integral cast body with sensor s/n ≥ 300000

3. Using a FOUNDATION fieldbus-compliant host, verify the electronics software revision.
4. With the information obtained from steps 1, 2, and 3, use the table below to make the necessary adjustments.

Sensor Serial Number	Meter Body Designator	Electronics Model 8800	Electronics Model 8800A Software Rev 3 or 4	Electronics Model 8800A or Model 8800C Software Rev 5 or higher
< 30000	None or A	No adjustment necessary.	No adjustment necessary.	Enter meter body designator “none” into electronics.
	B	Not Compatible – purchase new sensor.	Not Compatible – purchase new sensor.	Not Compatible – purchase new sensor.
≥ 0	None or A	Move low pass filter one step from default to a LOWER frequency.	Move low pass filter one step from default to a LOWER frequency.	Enter meter body designator “A” into electronics.
	B	No adjustment necessary	No adjustment necessary	Enter meter body designator “B” into electronics.

Replacing the Sensor: Removable and Integral Support Tubes

The following procedure applies to flowmeters equipped with a removable support tube, i.e. all flanged meters and ½- through 4-inch (DN 15 through 100) wafer meters.

1. De-pressurize the flow line.

NOTE
Sensor cavity could contain line pressure if an abnormal failure has occurred inside the meter body. De-pressurize flow line before removing the sensor nut.

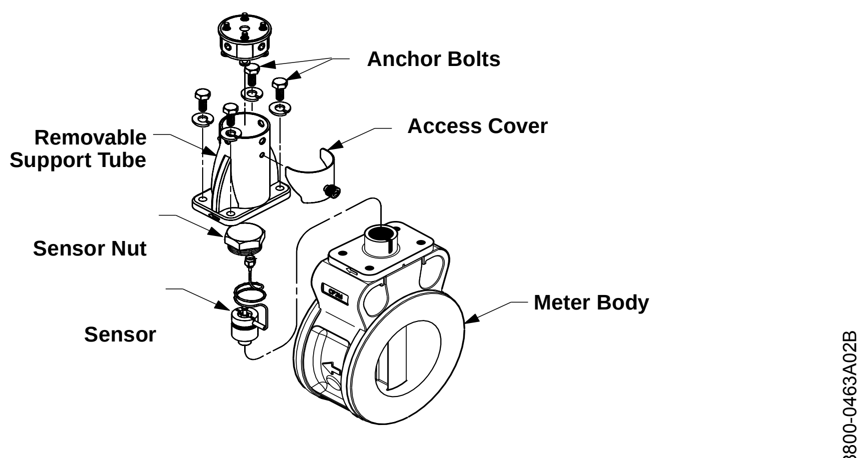
2. Remove the electronics housing (see page 6-10).

   For meters with a removable support tube (1/2- to 4-in. [15 to 100 mm] wafer meters and all flanged meters) , follow steps 3-5.

Removable Support Tube (for 1/2- to 4-in. wafer meters and all flanged meters)

3. Loosen the four support tube anchor bolts with a 7/16-inch open end wrench. (See Figure 6-10.)
4. Remove the support tube.

FIGURE 6-10.
Removable Support Tube Assembly.



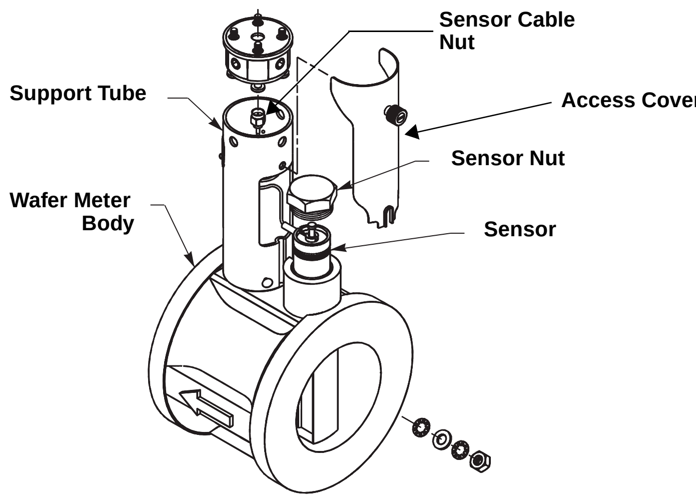
5. Proceed to step 8.

   For meters with an integral support tube, (6- to 8-in. [100 to 200 mm] wafer meters), follow steps 6-7.

Integral Support Mount (for 6- to 8-in. wafer meters)

6. Remove access cover. (See Figure 6-11.)

FIGURE 6-11. Integral Support Tube Assembly.



7. Proceed to step 8.
8. Loosen and remove the sensor nut from the sensor cavity with a 1 1/8-inch open end wrench. (Use a 3/4-inch open end wrench for 3- and 4-inch [80 and 100 mm] SST wafers.)
9. Lift the sensor from the sensor cavity. Be very careful to lift the sensor straight up. Do not rock, twist, or tilt the sensor during removal; this will damage the engagement diaphragm.

Cleaning the Sealing Surface

Before installing a sensor in the meter body, clean the sealing surface by completing the following procedure. The metal o-ring on the sensor is used to seal the sensor cavity in the event that process fluid should corrode through the meter body and enter the sensor cavity. Be sure not to scratch or otherwise damage any part of the sensor, sensor cavity, or sensor nut threads. Damage to these parts may require replacement of the sensor or meter body, or may render the flowmeter dangerous.

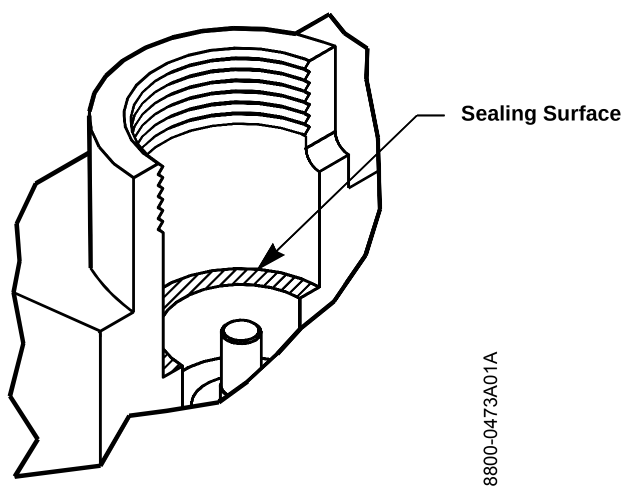
NOTE
If you are installing a sensor that has been used before, clean the metal o-ring on the sensor using the procedure above. If you are installing a newly purchased sensor, cleaning the o-ring is not necessary.

1. Use a suction or compressed air device to remove any loose particles from the sealing surface and other adjacent areas in the sensor cavity.

NOTE
Do not scratch or deform any part of the sensor, sensor cavity, or sensor nut threads.

2. Carefully brush the sealing surface clean with a soft bristle brush.
3. Moisten a cotton swab with an appropriate cleaning liquid.
4. Wipe the sealing surface. Repeat several times if necessary with a clean cotton swab until there is minimal dirt residue picked up by the cotton swab.

FIGURE 6-12.
O-Ring Sealing Surface in Sensor Cavity.



Sensor Installation

1. Carefully place sensor over the post in the sensor cavity.
2. Insure that the sensor is centered on the post. See Figure 6-13 for an example of improper installation and Figure 6-14 for an example of proper installation.

FIGURE 6-13. Sensor Installation – Improper Alignment.

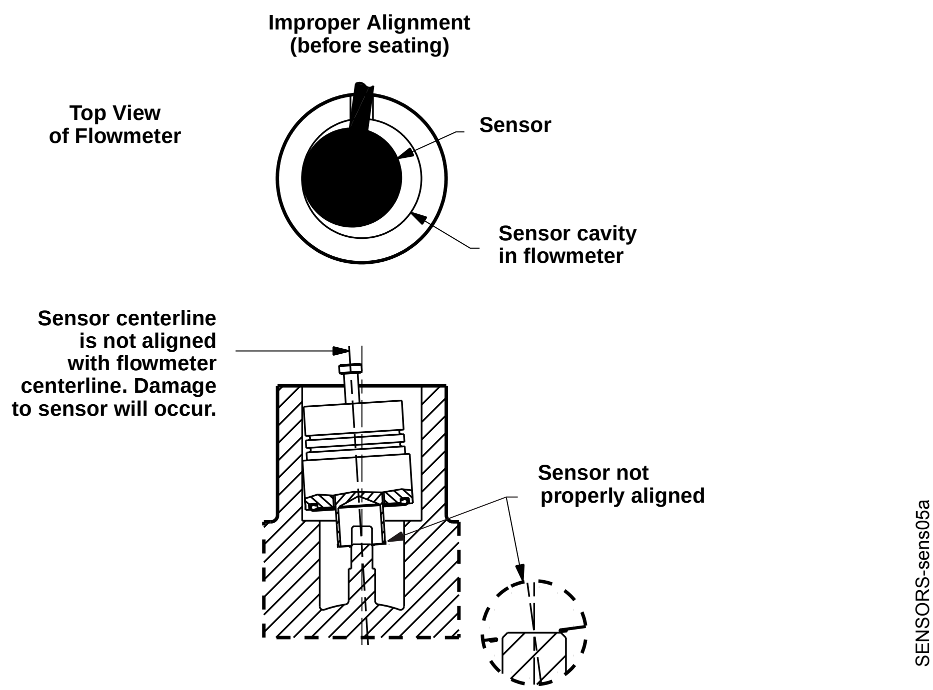
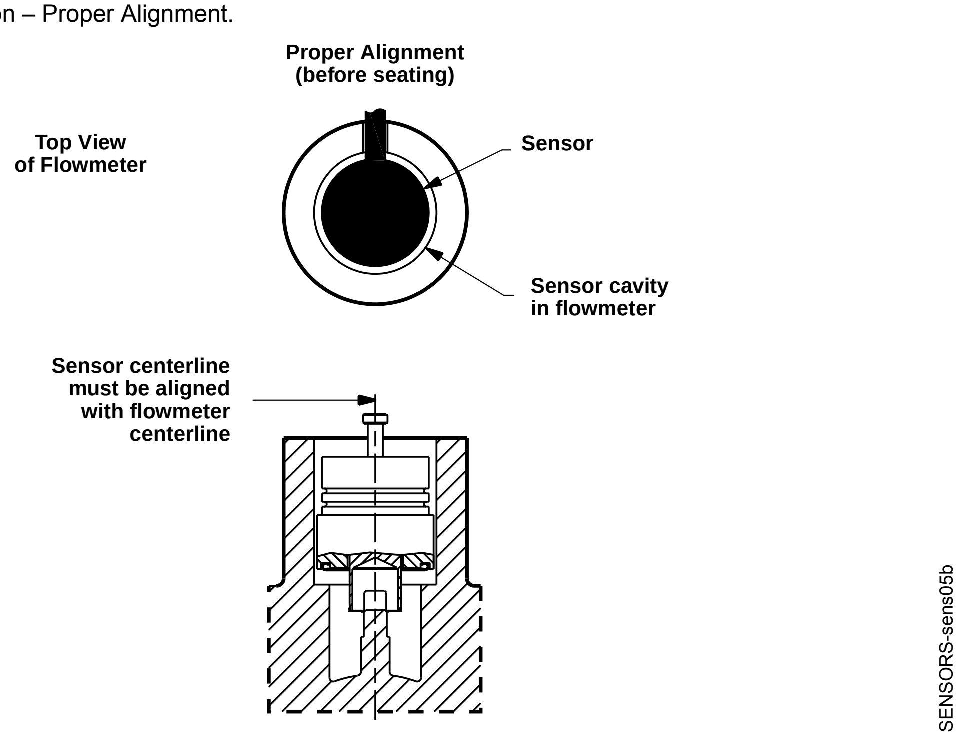
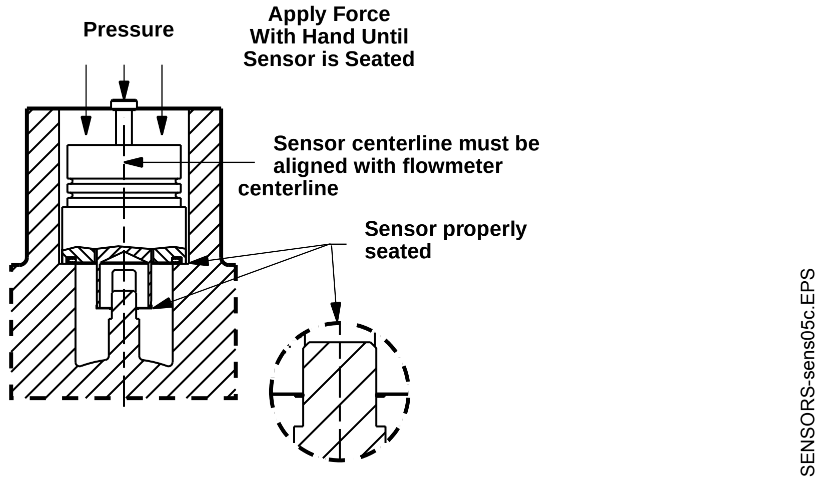


FIGURE 6-14. Sensor Installation – Proper Alignment.



3. Sensor should remain as close to vertical as possible when applying force to seat. See Figure 6-15.

FIGURE 6-15. Sensor Installation – Applying Force.



4. Manually push down on the sensor by applying equal pressure for engagement onto the post.
5. Screw the sensor nut into the sensor cavity. Tighten the nut with a 1 1/8-inch open end torque wrench to 32 ft-lbs. (Use a 3/4-inch open end wrench for 3- and 4-inch [80 and 100 mm] SST wafers.)

NOTE
The sensor nut must be tightened to 32 ft-lbs. for accurate flowmeter operation.

6. Replace the support tube.
7. Tighten the four bolts that anchor the support tube in place with a 7/16-inch open end wrench.
8. Install the flowmeter electronics housing (see page 6-10).

Remote Electronics Procedure

If the Model 8800C electronics housing is mounted remotely, some replacement procedures are different than for the flowmeter with integral electronics. The following procedures are exactly the same:

- Replacing the Field Terminal Block (see page page 6-8).
- Replacing the Electronics Boards (see page page 6-9).
- Replacing the Sensor (see page page 6-12).

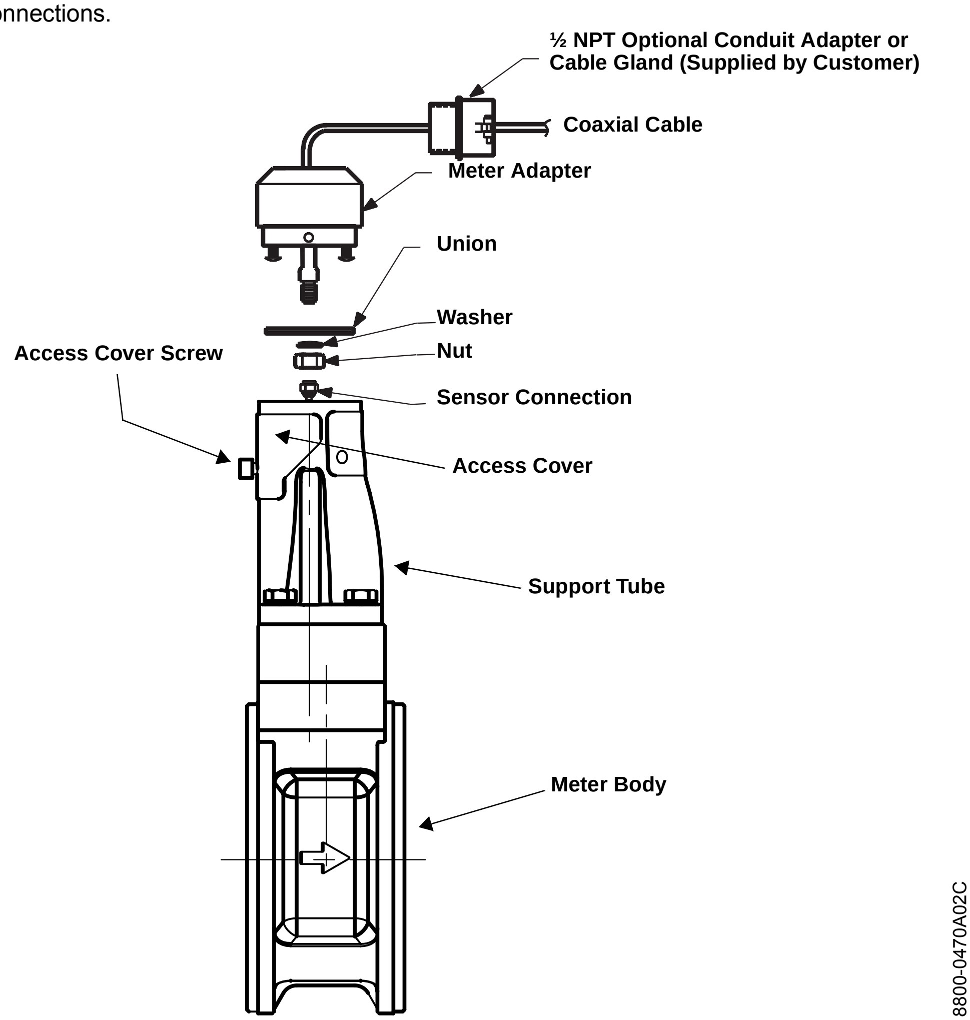
To disconnect the coaxial cable from the meter body and electronics housing, follow the instructions below.

Disconnect the Coaxial Cable at the Meter

1. Remove the access cover on the meter body support tube.
2. Loosen the three housing rotation screws at the base of the electronics housing with a hex wrench by turning the screws clockwise (inward) until they will clear the bracket.
3. Loosen and remove the sensor cable nut from the union using a 5/16-inch open end wrench.

NOTE
Do not pull the adaptor more than 1.5 inches (40 mm) from the top of the support tube. Damage to the sensor may occur if the sensor cable is stressed.

FIGURE 6-16. Coaxial Cable Connections.



Detach the Meter Adapter

The above instructions will provide access to the meter body. Use the following steps if it is necessary to remove the coaxial cable:

1. Loosen the two screws that hold the union onto the meter adapter and pull the union away from the adapter.
2. Loosen and remove the coaxial cable nut from the other end of the union.
3. Loosen the conduit adapter or cable gland from the meter adapter.

Attach the Meter Adapter

1. If you are using a conduit adapter or cable gland, slide it over the plain end of the coaxial cable (the end without a ground wire).
2. Slide the meter adapter over the coaxial cable end.
3. Use a $^5/_{16}$-inch open end wrench to securely tighten the coaxial cable nut onto one end of the union.
4. Place the union onto the two screws extending out of the meter adapter and tighten the two screws.

Connect the Coaxial Cable at the Meter

1. Pull the sensor cable out of the support tube slightly and securely tighten the sensor cable nut onto the union.

NOTE
Do not stretch the sensor cable over 1.5 inches (40 mm) beyond the top of the support tube. Damage to the sensor may occur if the sensor cable is stressed.

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2. Place the meter adapter into the top of the support tube and line up the screw holes.
3. Use a hex wrench to turn the three adapter screws outward to engage the support tube.
4. Replace the access cover on the support tube.
5. Tighten the conduit adapter or cable gland into the meter adapter.

Coaxial Cable at the Electronics Housing

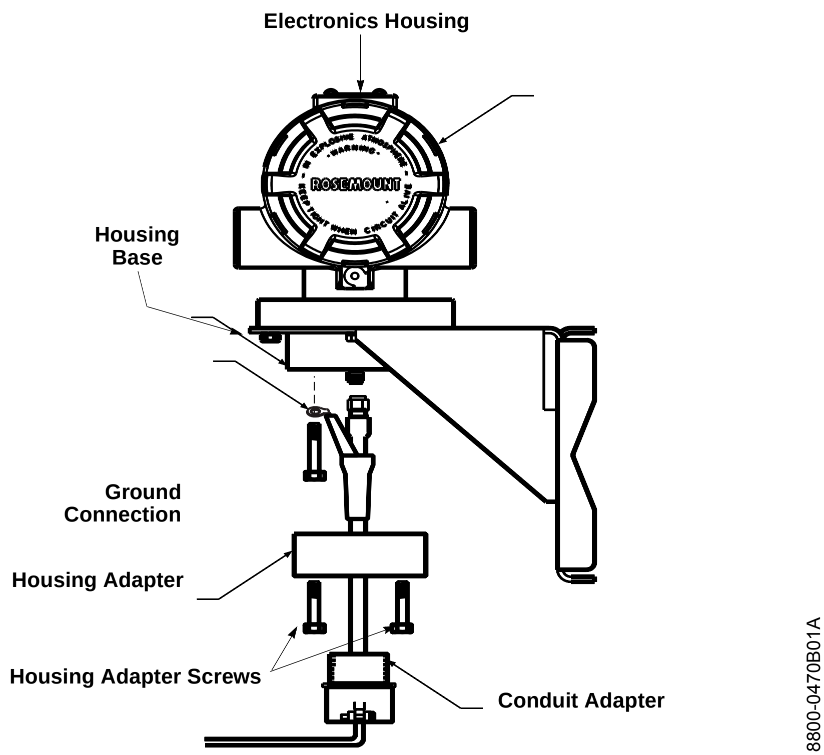
Disconnect the Coaxial Cable from the Electronics Housing

1. Loosen the three screws from the housing adapter.
2. Remove the adapter from the housing.
3. Loosen and remove the coaxial cable nut from the base of the electronics housing.

Remove the Coaxial Cable

1. Remove the coaxial cable ground wire from the housing adapter

FIGURE 6-17.
Remote Electronics Exploded View.



2. Loosen the conduit adapter (or cable gland) from the housing adapter.

Attach the Coaxial Cable

1. Route the coaxial cable through the conduit (if you are using conduit).
2. Place a conduit adapter over the end of the coaxial cable.
3. Remove the housing adapter from the electronics housing (if attached).
4. Slide the housing adapter over the coaxial cable.
5. Remove one of the four housing base screws.
6. Attach the coaxial cable ground wire to the housing via the housing base ground screw.

Connect the Coaxial Cable

1. Attach and securely tighten the coaxial cable nut to the connection on the electronics housing.
2. Align the housing adapter with the housing and attach with three screws.
3. Tighten the conduit adapter to the housing adapter.

Connect the coaxial cable

1. Attach and securely tighten the coaxial cable nut to the connection on the electronics housing.
2. Align the housing adapter with the housing and attach with three screws.
3. Tighten the conduit adapter to the housing adapter.

Changing the FOUNDATION Fieldbus Housing Orientation

The entire electronics housing may be rotated in 90° increments for easy viewing. Use the following steps to change the housing orientation:

1. Loosen the screw on the access cover (on the support tube) and remove the cover.
2. Loosen the three housing rotation set screws at the base of the electronics housing with a hex wrench one and one-half full turns.
3. Slowly pull the electronics housing out of the support tube.
4. Unscrew the sensor cable from the housing with a 5/16 in. open-end wrench.

NOTE
Do not pull the housing more than 1.5 in. (40 mm) from the top of the support tube until the sensor cable is disconnected. Damage to the sensor may occur if this sensor cable is stressed.

5. Rotate the housing to the desired orientation.
6. Hold it in this orientation while you screw the sensor cable onto the base of the housing.

NOTE
Do not rotate the housing while the sensor cable is attached to the base of the housing. Doing so will stress the cable and may damage the sensor.

7. Place the electronics housing into the top of the support tube.
8. Use a hex wrench to turn the three housing rotation screws outward to engage the support tube.
9. Replace the access cover on the support tube.
10. Tighten the screw on the access cover.

RETURN OF MATERIAL

To expedite the return process, call the Rosemount North American Response Center at 800-654-RSMT (7768). The center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the name of the process material to which the product was last exposed.

CAUTION

People who handle products exposed to a hazardous substance can avoid injury if they are informed and understand the hazard. If the product being returned was exposed to a hazardous substance as defined by OSHA, a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.

The Rosemount North American Response Center will detail the additional information and procedures necessary to return goods exposed to hazardous substances.

Section 7 Options

The options available for the Model 8800C Flowmeter are described in this section. The numbers in parentheses refer to the codes used to order each option.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please refer to the following safety messages before performing any operation in this section.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Before connecting a FOUNDATION fieldbus-compliant host in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

LCD INDICATOR

The LCD indicator (option code M5) provides local indication of the output and abbreviated diagnostic messages governing operation of the flowmeter. The indicator is located on the circuit side of the flowmeter electronics, leaving direct access to the signal terminals. An extended cover is required to accommodate the indicator. Figure 7-1 shows the flowmeter fitted with the LCD indicator and extended cover.

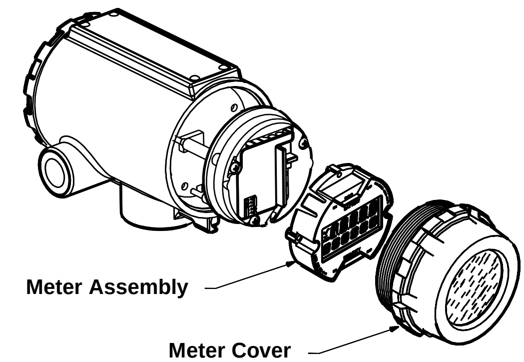


Figure 7-1. Model 8800C Flowmeter with FOUNDATION Fieldbus with Optional Indicator.

The indicator features an eight-character (and five alphanumeric) LCD that gives a direct reading of the digital signal from the microprocessor. During normal operation, the display can be configured to alternate between three readings:

1. Primary flow variable in engineering units
2. Percent of range
3. Vortex shedding frequency (Hz)

Figure 7-2 shows the indicator display with all segments lit.

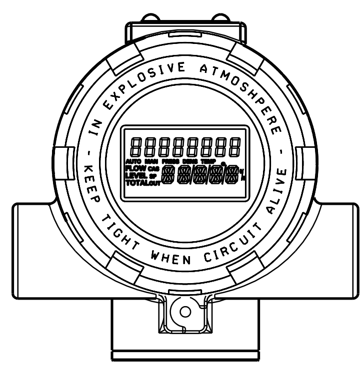


Figure 7-2. Optional LCD.

The Fisher-Rosemount DeltaV Fieldbus Configuration Tool, or other FOUNDATION fieldbus compliant host can be used to change the engineering units displayed on the indicator. (See Section 3: Flowmeter Operation for more information.)

Installing the Indicator

For flowmeters ordered with the LCD indicator, the indicator is shipped installed. When purchased separately from the Model 8800C Flowmeter, you must install the indicator using a small instrument screwdriver and the indicator kit. The indicator kit includes:

- One LCD indicator assembly
- One extended cover with O-ring installed
- One connector
- Two mounting screws

Referring to Figure 7-1, use the following steps to install the LCD indicator:

1. If the flowmeter is installed in a loop, secure the loop and disconnect the power.
2. Remove the flowmeter cover on the electronics side.

NOTE
The circuit board is electrostatically sensitive. Be sure to observe handling precautions for static-sensitive components.

3. Insert the mounting screws into the LCD indicator.
4. Remove the two jumpers on the circuit board that coincide with the SIMULATE ENABLE and the SECURITY settings.
5. Insert the connector into the SIMULATE ENABLE/ SECURITY junction.
6. Gently slide the LCD indicator onto the connector and tighten the screws into place.
7. Insert jumpers into SIMULATE ENABLE and SECURITY positions on the face of the LCD indicator.
8. Attach the extended cover and tighten at least one-third turn past O-ring contact.

NOTE
The indicator may be installed in 90° increments for easy viewing. One of the four connectors on the back of the indicator assembly must be positioned to fit into the ten-pin connector on the electronic board stack.

Note the following LCD temperature limits:

Operating: –4 to 185 °F (–20 to 85 °C).
Storage: –50 to 185 °F (–46 to 85 °C).

Diagnostic Messages

In addition to the output, the LCD indicator displays diagnostic messages for troubleshooting the flowmeter. These messages are as follows:

FAULT_ROM

The flowmeter electronics have undergone an EPROM checksum fault. Contact your field service center.

FAULT_EEROM

The flowmeter electronics have undergone an EEPROM checksum fault. Contact your field service center.

FAULT_RAM

The flowmeter electronics have undergone a RAM test fault. Contact your field service center.

FAULT_ASIC

The flowmeter electronics have undergone a digital signal processing ASIC update fault. Contact your field service center.

FAULT_COPRO

The flowmeter electronics have detected a fault in the math coprocessor. Consult your field service center.

FAULT_SFTWR

The flowmeter electronics have detected a nonrecoverable fault in the software operation. Consult your field service center.

Section 8

Specifications

SPECIFICATIONS

Functional Specifications

Service

Liquid, gas, and steam applications. Fluids must be homogeneous and single-phase.

Line Sizes

Wafer, Flanged, and Dual-Sensor Style

½, 1, 1½, 2, 3, 4, 6, and 8 in.
(DN 15, 25, 40, 50, 80, 100, 150, and 200).

Pipe Schedules

Process piping schedules 10, 40, and 80.

NOTE
The appropriate bore diameter of the process piping must be entered using any FOUNDATION fieldbus-compliant host, such as the DeltaV system with AMS inside from Fisher-Rosemount. Meters will be shipped from the factory at the Schedule 40 default value unless otherwise specified.

Measurable Flow Rates

The Model 8800C flowmeter is capable of processing signals from flow applications that meet the appropriate flowmeter sizing requirements. To determine the appropriate flowmeter size for an application, process conditions must be within the Reynolds number and velocity limitations for the desired line size provided in Tables 1 through 3.

NOTE
Consult your local sales representative to obtain a computer-sizing program that describes in greater detail how to specify the correct flowmeter size for an application.

The Reynolds number equation shown below combines the effects of density (ρ), viscosity (μ_{cp}), inside pipe diameter (D), and flow rate (V).

$$R_D = \frac{VD\rho}{\mu_{c\rho}}$$

TABLE 8-1. Minimum Measurable Reynolds Numbers.

Line Sizes (in./mm)	Reynolds Number Limitations
½–4 (15–100)	10,000 minimum
6–8 (150–200)	20,000 minimum

TABLE 8-2. Minimum Measurable Velocities
(Use the Larger of the Two Values).

	Feet Per Second	Meters Per Second
Liquids	$\sqrt{36/\rho}$ or 0.7	$\sqrt{54/\rho}$ or 0.22
Gases	$\sqrt{36/\rho}$ or 6.5	$\sqrt{54/\rho}$ or 2.0

TABLE 8-3. Maximum Measurable Velocities
(Use the Smaller of the Two Values).

	Feet Per Second	Meters Per Second
Liquids	$\sqrt{90{,}000/\rho}$ or 25	$\sqrt{134{,}000/\rho}$ or 7.6
Gases	$\sqrt{90{,}000/\rho}$ or 250	$\sqrt{134{,}000/\rho}$ or 76

NOTE
The ρ in Tables 2 and 3 is the process fluid density at flowing conditions in lb/ft^3 for ft/s and kg/m^3 for m/s.

Process Temperature Limits

Standard

–40 to 450 °F (–40 to 232 °C).

Extended

–330 to 800 °F (–200 to 427 °C).

Ambient Temperature Limits

Operating

–58 to 185 °F (–50 to 85 °C).

–4 to 185 °F (–20 to 85 °C) for flowmeters with local indicator.

Storage

–58 to 250 °F (–50 to 121 °C).

–50 to 185 °F (–46 to 85 °C) for flowmeters with local indicator.

Output Signals

Manchester-encoded digital signal that conforms to IEC 1158-2 and ISA 50.02.

TABLE 8-4. Water Flow Rate Limits in Schedule 40 Pipe.

Line Size (inches/DN)	Minimum and Maximum Measurable Water Flow Rates *	
	Gallons/Minute	Cubic Meters/Hour
½/15	1.82 to 23.7	0.41 to 5.38
1/25	3.08 to 67.3	0.70 to 15.3
1½/40	4.83 to 158	1.10 to 35.9
2/50	7.96 to 261	1.81 to 59.4
3/80	17.5 to 576	4.00 to 130
4/100	30.2 to 992	6.86 to 225
6/150	68.6 to 2,251	15.6 to 511
8/200	119 to 3,898	27.0 to 885

*** Conditions: 77 °F (25 °C) and 14.7 psia (1.01 bar absolute)**

TABLE 8-5. Air Flow Rate Limits at 59 °F (15 °C).

Process Pressure	Flow Rate Limits	½ in./DN 15 ACFM	½ in./DN 15 ACMH	1 in./DN 25 ACFM	1 in./DN 25 ACMH	1½ in./DN 40 ACFM	1½ in./DN 40 ACMH	2 in./DN 50 ACFM	2 in./DN 50 ACMH
		Minimum and Maximum Air Flow Rates							
0 psig (0 bar gauge)	max min	27.9 4.29	47.3 7.29	79.2 7.81	134 13.3	211 18.4	359 31.2	349 30.3	593 51.5
50 psig (3.45 bar gauge)	max min	27.9 1.31	47.3 2.22	79.2 3.72	134 6.32	211 8.75	359 14.9	349 14.5	593 24.6
100 psig (6.89 bar gauge)	max min	27.9 0.99	47.3 1.67	79.2 2.80	134 4.75	211 6.57	359 11.2	349 10.9	593 18.5
150 psig (10.3 bar gauge)	max min	27.9 0.83	47.3 1.40	79.2 2.34	134 3.98	211 5.50	359 9.34	349 9.09	593 15.4
200 psig (13.8 bar gauge)	max min	27.9 0.83	47.3 1.40	79.2 2.34	134 3.98	211 5.50	359 9.34	349 9.09	593 15.4
300 psig (20.7 bar gauge)	max min	27.9 0.83	47.3 1.40	79.2 2.34	134 3.98	198 5.50	337 9.34	327 9.09	556 15.4
400 psig (27.6 bar gauge)	max min	25.9 0.83	43.9 1.40	73.5 2.34	124 3.98	172 5.50	293 9.34	285 9.09	485 15.4
500 psig (34.5 bar gauge)	max min	23.2 0.83	39.4 1.40	66.0 2.34	112 3.98	155 5.50	263 9.34	256 9.09	435 15.4

Process Pressure	Flow Rate Limits	3 in./DN 80 ACFM	3 in./DN 80 ACMH	4 in./DN 100 ACFM	4 in./DN 100 ACMH	6 in./DN 150 ACFM	6 in./DN 150 ACMH	8 in./DN 200 ACFM	8 in./DN 200 ACMH
		Minimum and Maximum Air Flow Rates							
0 psig (0 bar gauge)	max min	769 66.8	1,307 114	1,326 116	2,253 196	3,015 262	5,122 445	5,211 453	8,853 769
50 psig (3.45 bar gauge)	max min	769 31.8	1,307 54.1	1,326 54.8	2,253 93.2	3,015 125	5,122 212	5,211 216	8,853 367
100 psig (6.89 bar gauge)	max min	769 23.9	1,307 40.6	1,326 41.2	2,253 70.0	3,015 93.7	5,122 160	5,211 162	8,853 276
150 psig (10.3 bar gauge)	max min	769 20.0	1,307 34.0	1,326 34.5	2,253 58.6	3,015 78.4	5,122 134	5,211 136	8,853 231
200 psig (13.8 bar gauge)	max min	769 20.0	1,307 34.0	1,326 34.5	2,253 58.6	3,015 78.4	5,122 134	5,211 136	8,853 231
300 psig (20.7 bar gauge)	max min	721 20.0	1,226 34.0	1,243 34.5	2,112 58.6	2,827 78.4	4,803 134	4,886 136	8,302 231
400 psig (27.6 bar gauge)	max min	628 20.0	1,068 34.0	1,083 34.5	1,840 58.6	2,463 78.4	4,184 134	4,257 136	7,232 231
500 psig (34.5 bar gauge)	max min	564 20.0	958 34.0	972 34.5	1,652 58.6	2,210 78.4	3,756 134	3,821 136	6,492 231

NOTE

The Model 8800C Flowmeter measures the volumetric flow under operating conditions (i.e., the actual volume at the operating pressure and temperature—acfm or acmh), as shown above. However, gas volumes are strongly dependent on pressure and temperature. Therefore, gas quantities are typically stated in standard or normal conditions (e.g., scfm or ncmh). (Standard conditions are typically 59 °F and 14.7 psia. Normal conditions are typically 0 °C and 1 bar abs.)

The flow rate limits in standard conditions are found using the equations below.
Standard Flow Rate = Actual Flow Rate X Density Ratio.
Density Ratio = Density at Actual (Operating) Conditions/Density at Standard Conditions.

TABLE 8-6. Saturated Steam Flow Rate Limits.

Process Pressure	Flow Rate Limits	Minimum and Maximum Saturated Steam(1) Flow Rates							
		½ in./DN 15		1 in./DN 25		1½ in./DN 40		2 in./DN 50	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1.03 bar gauge)	max min	120 14.8	54.6 6.70	342 34.8	155 15.8	914 81.8	414 37.1	1,511 136	685 61.3
25 psig (1.72 bar gauge)	max min	158 14.8	71.7 6.70	449 39.9	203 18.1	1,200 93.7	544 42.5	1,983 155	899 70.2
50 psig (3.45 bar gauge)	max min	250 17.6	113 8.00	711 50.1	322 22.7	1,898 118	861 53.4	3,138 195	1,423 88.3
100 psig (6.89 bar gauge)	max min	429 23.1	194 10.5	1,221 65.7	554 29.8	3,261 155	1,479 70.1	5,389 256	2,444 116
150 psig (10.3 bar gauge)	max min	606 27.4	275 12.5	1,724 78.1	782 35.4	4,604 184	2,088 83.2	7,608 304	3,451 138
200 psig (13.8 bar gauge)	max min	782 31.2	354 14.1	2,224 88.7	1,009 40.2	5,940 209	2,694 94.5	9,817 345	4,553 157
300 psig (20.7 bar gauge)	max min	1,135 37.6	515 17.0	3,228 107	1,464 48.5	8,621 252	3,910 114	14,246 415	6,461 189
400 psig (27.6 bar gauge)	max min	1,492 44.1	676 20.0	4,243 126	1,924 56.9	11,332 295	5,140 134	18,725 487	8,493 221
500 psig (34.5 bar gauge)	max min	1,855 54.8	841 24.9	5,275 156	2,393 70.7	14,089 367	6,390 167	23,282 606	10,560 275

(1) Assumes Steam Quality is 100%.

Process Pressure	Flow Rate Limits	Minimum and Maximum Saturated Steam(1) Flow Rates							
		3 in./DN 80		4 in./DN 100		6 in./DN 150		8 in./DN 200	
		lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15 psig (1.03 bar gauge)	max min	3,327 298	1,509 135	5,733 513	2,600 233	13,037 1,166	5,913 529	22,533 2,015	10,221 914
25 psig (1.72 bar gauge)	max min	4,367 341	1,981 155	7,525 588	3,413 267	17,112 1,336	7,761 606	29,575 2,308	13,415 1,047
50 psig (3.45 bar gauge)	max min	6,908 429	3,133 195	11,905 739	5,400 335	27,070 1,680	12,279 762	46,786 2,903	21,222 1,317
100 psig (6.89 bar gauge)	max min	11,866 563	5,382 255	20,447 969	9,274 440	46,491 2,202	21,088 999	80,354 3,806	36,448 1,727
150 psig (10.3 bar gauge)	max min	16,751 668	7,598 303	28,865 1,150	13,093 522	65,632 2,615	29,770 1,187	113,436 4,520	51,454 2,050
200 psig (13.8 bar gauge)	max min	21,614 759	9,804 344	37,246 1,307	16,896 593	84,688 2,971	38,414 1,348	146,371 5,135	66,393 2,330
300 psig (20.7 bar gauge)	max min	31,366 914	14,227 415	54,049 1,574	24,516 714	122,894 3,579	55,744 1,624	212,405 6,186	96,346 2,806
400 psig (27.6 bar gauge)	max min	41,228 1,072	18,701 487	71,044 1,848	32,225 838	161,536 4,200	73,272 1,906	279,192 7,259	126,639 3,293
500 psig (34.5 bar gauge)	max min	51,259 1,333	23,251 609	88,330 2,297	40,066 1,042	200,840 5,222	91,100 2,369	347,124 9,026	157,453 4,094

Pressure Limits

Flange and wafer rated for ASME B16.5 (ANSI) Class 150, 300, and 600; DIN PN 10, 16, 25, 40, 64, and 100; and JIS 10K, 20K, and 40K.

Power Supply

External power supply required. Flowmeter operates on 9 to 32 V dc, 17.8 mA nominal, 19.0 mA maximum.

Optional LCD Indicator

Displays flow variable, percent of range, and vortex shedding frequency.

Enclosure Rating

NEMA Type 4X, CSA Type 4X, IP66.

Hazardous Locations Certifications

Factory Mutual (FM) Approvals

E5 Explosion Proof for Class I, Division 1, Groups B, C, and D.
Dust-Ignition Proof for Class II/III, Division 1, Groups E, F, and G.
Factory sealed.

I5 Intrinsically safe for use in Class I, Division 1, Groups A, B, C, and D. Class II/III, Division 1, Groups E, F, and G. Temp. Code T4 only when connected in accordance with Rosemount drawings 08800-0106 and 00268-0031. Non-incendive for Class I, Division 2, Groups A, B, C, and D. Factory sealed. Entity Parameters:
V_{max} = 30 V
I_{max} = 300 mA
C_i = 0.0 µF
L_i = 20 µH.

K5 E5 and I5 combination.
V_{max} = 30 V
I_{max} = 300 mA
C_i = 0.0 µF
L_i = 20 µH.

BASEEFA/CENELEC Intrinsic Safety Certification

I1 EEx ia IIC T4 (T_{amb} = -50 °C to 60 °C)
Entity Parameters:
UI= 30 V
Ii[(1)] = 300 mA
PI[(1)] = 1.3 W
C_i = 0.0 µF
L_i = 20 µH.

BASEEFA Type N Certification

N1 Ex nL IIC T5 (T_{amb} = -40 °C to 70 °C)
42 Vdc max.

(1) Total for transmitter.

KEMA/CENELEC Flameproof Certifications

ED EEx d ia IIC T6 (T_{amb}=70 °C)

Special Conditions

When installing the instrument, particular precautions must be taken to ensure that the fluid temperature or the ambient temperature does not cause the temperature of the electrical parts to deviate from the proper temperature range (between -20 °C and 70 °C).

Canadian Standards Association (CSA) Approvals

E6 Explosion Proof for Class I, Division 1, Groups B, C, and D; Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G; Class III, Division 1 hazardous locations. Class I, Division 2, Groups A, B, C, and D. Factory sealed.

I6 Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D. Intrinsic safety approval only when connected in accordance with Rosemount drawing 08800-0111. Temperature Code T3C. See Table 11.

C6 E6 and I6 combination. See Table 11.

TABLE 8-7. CSA Entity Approvals.

Barrier Manufacturer/Model	CSA Approved for Class I, Division 1, Groups			
	A	B	C	D
Any CSA approved zener barrier ≤ 30 V, ≥ 330 Ω or ≤ 28 V, ≥ 300 Ω or ≤ 25 V, ≥ 200 Ω or ≤ 22 V, ≥ 180 Ω	•	•	•	•
Foxboro Converters 2AI-12V-CGB, 2AI-13V-CGB 2AS-I3I-CGB, 3A2-I2D-CGB 3A2-I3D-CGB, 3AD-I3I-CGB 3A4-I2D-CGB, 2AS-I2I-CGB 3F4-I2DA	NA	•	•	•
Any CSA approved zener barrier ≤ 30 V, ≥ 150 Ω	NA	NA	•	•

Standards Association of Australia (SAA) Certification

E7 Flameproof:
Ex d ia IIC T6 (T_{amb} = 40 °C)
Ex d ia IIC T4 (T_{amb} = 85 °C)
Class I, Zone I. IP66.
AUS Ex 3012X

Pressure Loss

Equations to determine approximate pressure loss:

English

$$(Liquids)\Delta P = \frac{(3.40 \times 10^{-5}) \times \rho_f \times (Q_{gpm})^2}{D^4}$$

$$(Gases)\Delta P = \frac{(1.90 \times 10^{-3}) \times \rho_f \times (Q_{acfm})^2}{D^4}$$

Metric

$$(Liquids)\Delta P = \frac{(0.425) \times \rho_f \times (Q_{lpm})^2}{D^4}$$

$$(Gases)\Delta P = \frac{(118) \times \rho_f \times (Q_{acmh})^2}{D^4}$$

where:

ΔP = Pressure loss (psi or kPa)

ρ_f = Density at operating conditions (lb/ft^3 or kg/m^3)

D = Flowmeter bore diameter (in. or mm)

$Q_{gpm\ or\ lpm}$ = Actual volumetric flow rate (gallons/minute or liters/minute)

$Q_{acfm\ or\ acmh}$ = Actual volumetric flow rate (cubic feet/min or cubic meters/hour)

NOTE
Pressure loss is 1.8 ΔP for the dual-sensor meter.

Minimum Back Pressure (Liquids)

Cavitation, the release of vapor from a liquid, may be avoided by remaining within the proper flow range of the meter and by following appropriate system design. For some liquid applications, incorporation of a back pressure valve should be considered. To prevent cavitation, the minimum back pressure should be:

$$P = 2.9\Delta P + 1.3\ p_v$$

where:

P = Line pressure, five pipe diameters downstream of the meter (psia or kPa)

ΔP = Pressure loss across the meter (psi or kPa)

p_v = Liquid vapor pressure at operating conditions (psia or kPa)

NOTE
Pressure loss is 1.8 ΔP for the dual-sensor meter.

Damping

Adjustable between 0.2 and 255 seconds.

Response Time

Maximum time required to reach 63.2% of actual input flow with minimum damping (0.2 seconds) shall be 0.2 seconds or three vortex shedding cycles, whichever is greater.

Turn-on Time

Performance within specifications no greater than 10.0 seconds after power is applied.

Alarms

The AI block allows the user to configure the alarm to HI-HI, HI, LO, or LO-LO with a variety of priority levels.

Security

When the security jumper is on, the electronics will not allow you to modify parameters that affect flowmeter output.

Low Flow Cutoff

Adjustable over entire flow range. Below selected value, output damps to no flow.

Humidity Limits

Operates in 0–98% ±2% relative humidity. Tested to IEC 770, Section 6.2.11.

Overrange Capability

For liquid service type, the transducer block digital output will continue to a nominal value of 25 ft/s (7.6 m/s). After that, the status associated with the transducer block output will go to UNCERTAIN. Above a nominal value of 30 ft/s (9.1 m/s), the status will go to *BAD*.

For gas/steam service, the transducer block digital output will continue to a nominal value of 220 ft/s (67.1 m/s) for 0.5 and 1.0 in. (15 and 25 mm) line sizes and a nominal value of 250 ft/s (76.2 m/s) for 1.5–8 in. line sizes. After that, the status associated with the transducer block output will go to UNCERTAIN. Above a nominal value of 300 ft/s (91.4 m/s) for all line sizes, the status will go to *BAD*.

Flow Calibration

Meter bodies are flow calibrated and assigned a unique calibration factor (K-factor) at the factory. The calibration factor is entered into the electronics, enabling interchangeability of electronics and/or meter bodies without calculations or compromise in accuracy.

The K-factor is automatically compensated when changes are made to the pipe ID or process temperature.

Status

If self-diagnostics detect a transmitter failure, the status of the measurement will inform the control system. Status may also send the PID output to a safe value.

FOUNDATION Fieldbus Specifications

Schedule Entries

Six (6).

Links

Twelve (12).

Virtual Communications Relationships (VCRs)

Two (2) predefined (F6, F7).
Four (4) configurable (see Table 12).

TABLE 8-8. Block Information.

Block	Base Index	Execution Time (Milliseconds)
Resource (RB)	300	—
Transducer (TB)	400	—
Analog Input (AI)	1,000	15
Proportional/Integral/Derivative (PID)	10,000	25

Performance Specifications

Accuracy

(Includes linearity, hysteresis, and repeatability.)

Liquids—for Reynolds Numbers over 20,000

Digital and Pulse Output
±0.65% of rate.
Analog Output
Same as pulse output plus an additional 0.025% of span.

Gas and Steam—for Reynolds Numbers over 15,000

Digital and Pulse Output
±1.35% of rate.
Analog Output
Same as pulse output plus an additional 0.025% of span.

Accuracy limitations:

- for ½- and 1-in. (DN 15 and DN 25): max velocity of 220 ft/s (67.06 m/s)
- for Dual-style meters (all sizes): max velocity of 100 ft/s (30.5 m/s)

NOTE
As the Reynolds number decreases below the stated limit to 10,000, the positive limit of the accuracy error band will increase to 2.1% (e.g., +2.1% to –0.65% for liquids).

Stability

±0.1% of rate over one year.

Process Temperature Effect

Automatic K-factor correction with user-entered process temperature.

Table 13 indicates the percent change in K-factor per 100 °F (50 °C) in process temperature from reference temperature of 77 °F (25 °C) (for direct pulse) or user-entered process temperature.

TABLE 8-9. Process Temperature Effect.

Material	Percent Change in K-Factor per 100 °F (50 °C)
316L @ < 77 °F (25 °C)	+0.23 (+0.20)
316L @ > 77 °F (25 °C)	–0.27 (–0.24)
Hastelloy C @ < 77 °F (25 °C)	+0.22 (+0.20)
Hastelloy C @ > 77 °F (25 °C)	–0.22 (–0.20)

Ambient Temperature Effect

No effect.

Vibration Effect

An output with no process flow may be detected if sufficiently high vibration is present.

The meter design will minimize this effect, and the factory settings for signal processing are selected to eliminate these errors for most applications.

If an output error at zero flow is still detected, it can be eliminated by adjusting the low flow cutoff, trigger level, and/or low-pass filter.

As the process begins to flow through the meter, most vibration effects are quickly overcome by the flow signal. At or near the minimum liquid flow rates in a normal pipe mounted installation, the maximum vibration should be 0.087 in. (2.21 mm) double amplitude displacement or 1 g acceleration, whichever is smaller. At or near the minimum gas flow rates in a normal pipe mounted installation, the maximum vibration should be 0.043 in. (1.09 mm) double amplitude displacement or ½ g acceleration, whichever is smaller.

Mounting Position Effect

The meter will meet accuracy specifications when mounted in horizontal, vertical, or inclined pipelines.

EMI/RFI Effect

No effect on accuracy of digital output with twisted pair from 25 MHz to 1000 MHz for field strength of 10 V/m. Tested per EN 61326-1.

Magnetic-Field Interference

No effect on digital output accuracy at 30 A/m (rms). Tested per EN 61326-1.

Series Mode Noise Rejection

No effect on digital output accuracy at 1 V rms,
60 Hz. Meets IEC 770-1984, Section 6.2.4.2.

Common Mode Noise Rejection

No effect on digital output accuracy at 250 V rms,
60 Hz. According to FF-830-PS-2.0 test case 8.2.

Power Supply Effect

No effect on accuracy.

Physical Specifications

NACE Compliance

Meets the requirements of the National Association of Corrosion Engineers (NACE) Standard MR-01-75 (96).

Electrical Connections

½–14 NPT, PG 13.5, or M20 × 1.5 conduit threads. Communicator connections permanently fixed to terminal block.

Nonwetted Materials

Housing

Low-copper aluminum
(NEMA 4X, CSA Type 4X, IP66).

Paint

Polyurethane.

Cover O-rings

Buna-N.

Flanges

316/316L lap joint.

Process-Wetted Materials

Meter Body

316L wrought stainless and CF-3M cast stainless or Hastelloy C-22 and C-276 wrought Hastelloy or CX2MW and CW12MW cast Hastelloy.

Flanges

316/316L stainless steel.

Collars

Hastelloy C-22.

Surface Finish of Flanges and Collars

Standard: 125 to 250 µin. (3.1 to 6.3 µm) R_a roughness.

Smooth: 63 to 125 µin. (1.6 to 3.1 µm) R_a roughness.

Process Connections

Mounts Between the Following Flange Configurations

- ASME B16.5 (ANSI): Class 150, 300, and 600.
- DIN: PN 10, 16, 25, 40, 64, and 100.
- JIS: 10K, 20K, and 40K.

Mounting

Integral (Standard)

Electronics are mounted on meter body.

Remote (Optional)

Electronics may be mounted remotely from the meter body. Interconnecting coaxial cable available in nonadjustable 10, 20, and 30 foot lengths (3.0, 6.1, and 9.1 m). Consult factory for nonstandard lengths up to 75 feet (22.9 m). Remote mounting hardware includes a polyurethane-painted, carbon steel pipe mount bracket with one carbon steel u-bolt.

Pipe Length Requirements

The vortex meter may be installed with a minimum of ten straight pipe diameters (D) upstream and five downstream.

Rated accuracy is based on the number of pipe diameters from an upstream disturbance. An additional 0.5% shift in K-factor may be introduced between 10 D and 35 D, depending on disturbance. For more information on installation effects, see Technical Data Sheet 00816-0100-3250.

Tagging

A stainless steel tag is permanently attached to each flowmeter at no charge. Character height is 1/16 in. (1.6 mm). A wired-on tag is available on request.

A commissioning tag, attached to each flowmeter, will aid in the commissioning of the flowmeter on the fieldbus network by specifying the identification number and the location of the flowmeter.

Flow Calibration Information

Flowmeter calibration and configuration information is provided with every flowmeter. For a certified copy of flow calibration data, an Option Q4 must be ordered in the model number.

ORDERING INFORMATION

Model	Product Description	
8800C	Vortex Flowmeter, Stainless Steel Wafer, Flanged, and Dual-sensor and *Hastelloy* Flanged and Dual-sensor	•
8800A	Vortex Flowmeter, *Hastelloy* Wafer Meters Only	•
Code	**Meter Style**	
W	Wafer Style	•
F	Flanged Style	•
D	Dual-sensor Style (Flanged Style Only)	•
Code	**Line Size**	
005	½ in. (15 mm)	•
010	1 in. (25 mm)	•
015	1½ in. (40 mm)	•
020	2 in. (50 mm)	•
030	3 in. (80 mm)	•
040	4 in. (100 mm)	•
060	6 in. (150 mm)	•
080	8 in. (200 mm)	•
Code	**Wetted Materials**	
S	316L Wrought Stainless and CF-3M Cast Stainless	•
H(1)	*C-22* and C-276 Wrought *Hastelloy*, CX2MW and CW12MW Cast *Hastelloy* ½–8 in. (15–200 mm) Wafer and Flanged; ½–4 in. (15–100 mm) Dual-sensor Style	•
Code	**Flange or Alignment Ring Size**	
A1	ASME B16.5 (ANSI) RF Class 150	•
A3	ASME B16.5 (ANSI) RF Class 300	•
A6	ASME B16.5 (ANSI) RF Class 600	•
B1	ASME B16.5 (ANSI) RTJ Class 150 for Flanged Style Only	•
B3	ASME B16.5 (ANSI) RTJ Class 300 for Flanged Style Only	•
B6	ASME B16.5 (ANSI) RTJ Class 600 for Flanged Style Only	•
C1	ASME B16.5 (ANSI) RF Class 150, Smooth Finish	•
C3	ASME B16.5 (ANSI) RF Class 300, Smooth Finish	•
C6	ASME B16.5 (ANSI) RF Class 600, Smooth Finish	•
D0	DIN PN 10 2526-Type D	•
D1	DIN PN 16 (PN 10/16 for Wafer Style) 2526-Type D	•
D2	DIN PN 25 2526-Type D	•
D3	DIN PN 40 (PN 25/40 for Wafer Style) 2526-Type D	•
D4	DIN PN 64 2526-Type D	•
D6	DIN PN 100 2526-Type D(2)	•
G0	DIN PN 10 2512-Type N for Flanged Style Only	•
G1	DIN PN 16 2512-Type N for Flanged Style Only	•
G2	DIN PN 25 2512-Type N for Flanged Style Only	•
G3	DIN PN 40 2512-Type N for Flanged Style Only	•
G4	DIN PN 64 2512-Type N for Flanged Style Only	•
G6	DIN PN 100 2512-Type N for Flanged Style Only	•
H0	DIN PN 10 2526-Type E	•
H1	DIN PN 16 (PN 10/16 for Wafer Style) 2526-Type E	•
H2	DIN PN 25 2526-Type E	•
H3	DIN PN 40 (PN 25/40 for Wafer Style) 2526-Type E	•
H4	DIN PN 64 2526-Type E	•
H6	DIN PN 100 2526-Type E(2)	•
J1	JIS 10K	•
J2	JIS 20K	•
J4	JIS 40K	•
Code	**Sensor Process Temperature Range**	
N	Standard: –40 to 450 °F (–40 to 232 °C)	•
E	Extended: –330 to 800 °F (–200 to 427 °C)	•
Code	**Conduit Entry**	
1	½–14 NPT	•
2	M20 × 1.5	•
3	PG 13.5	•
Code	**Outputs**	
F	*FOUNDATION Fieldbus* Digital Signal(3)	•
Code	**Calibration**	
1	Flow Calibration	•
	Continued on Next Page	

Code	Options	
	PlantWeb Software Functions	
A01	Basic Control: One Proportional/Integral/Derivative (PID) Function Block	•
	Hazardous Location Certifications	
E5	Factory Mutual (FM) Explosion Proof Approval	•
I5	Factory Mutual (FM) Intrinsic Safety Approval	•
K5	Factory Mutual (FM) E5 and I5 Combination Approval	•
I1	BASEEFA/CENELEC Intrinsic Safety Certification	•
N1	BASEEFA Type N Certification	•
ED	KEMA/CENELEC Flameproof Certification	•
E6	Canadian Standards Association (CSA) Explosion Proof Approval	•
I6	Canadian Standards Association (CSA) Intrinsic Safety Approval	•
C6	Canadian Standards Association (CSA) E6 and I6 Combination Approval	•
E7	Standards Association of Australia (SAA) Flameproof Certification	•
	Other Options	
M5	LCD Indicator	•
P2	Cleaning for Special Services	•
R10	Remote Electronics with 10 ft (3.0 m) Cable	•
R20	Remote Electronics with 20 ft (6.1 m) Cable	•
R30	Remote Electronics with 30 ft (9.1 m) Cable	•
RXX	Remote Electronics with Customer-specified Cable Length (Up to 75 feet (23 m) Maximum)(4)	•
V5	External Ground Screw Assembly(5)	•
	Certification Options	
Q4	Calibration Data Sheet per ISO 10474 3.1.B	•
Q8	Material Traceability Certification per ISO 10474 3.1.B	•
Q14	German TRB 801 Nr.45 Certification per ISO 10474 3.1.B	•
Q69	Inspection Certificate Weld Examination (Wafer) per ISO 10474 3.1.B(6)	•
Q70	Inspection Certificate Weld Examination (Flanged) per ISO 10474 3.1.B	•
Q71	Inspection Certificate Weld Examination (Flanged) per ISO 10474 3.1.B (Includes X-Rays)	•
Typical Model Number:	**8800C F 020 S A1 N 1 F 1 A01 M5**	

(1) ½-4 in. (15-100 mm) flanged-style meters are with A1, A3, A6, C1, C3, D1, D3, D6, H1, H3, J1, J2, and J4 flange codes only.
6-in. (150 mm) and 8-in. (200 mm) are only available in A1, A3, A6, D1, D3, D6, J1, J2, and J4 flange codes.
½-4 in. (15-100 mm) with flange codes A1, A3, A6, C1, and C3; 2 in. (50 mm) through 4 in. (100 mm) with flange codes D1, D3, H1, and H3 codes use lap joint flanges; all others use weld-neck flanges.
Wafers are available with A1, A3, A6, D1, D3, D4, D6, J1, J2, and J4 flange codes only.
(2) D6 and H6 are not available for stainless steel 3-in. (80 mm) wafer meter style.
(3) Includes one analog input (AI) function block and Backup Link Active Scheduler.
(4) XX is customer-specified length in feet.
(5) The V5 option is only available with no approval or E5, I5, K5, E6, I6, or C6. Option V5 is standard with the other approvals and does not need to be ordered separately.
(6) Q69 only available for stainless steel ½-in. (15 mm), 6-in. (150 mm), and 8-in. (200 mm) line sizes.

CONFIGURATION DATA SHEET (CDS)

One completed configuration data sheet (00806-0100-4772) *is required* for *each* flowmeter ordered.

Application Information

The information requested on the front side of the CDS is required for each flowmeter purchased and provides important information regarding the specifics of the order, flow application, and configuration information. The factory will configure the flowmeter according to your specifications at no charge. Without this information, the factory will not be able to process your order.

Configuration Information

The back side of the CDS contains choices pertaining to special configuration options of the flowmeter software and hardware. If you specify configuration settings for the options you have ordered, the factory will configure the flowmeter, per your specification, for all options.

If you do not fill out the back of the CDS, the flowmeter will be configured to default settings where applicable.

Item	U.S. Unit (SI Unit)
Service	*Liquid*
Flow rate	*0 to meter maximum flow, GPM (ACMH)*
Density	*62.4 lb/ft^3 (1000 kg/m^3)*
Operating temperature	*68 °F (20 °C)*
Pipe ID	*Schedule 40 of line size*
Damping	*2 seconds*
LCD configuration	*Flow rate*
Simulate enable	*Off*
Security	*Off*
Software tag	*(Blank)*

Section **9**

Electronics Verification

Electronics verification of the Model 8800C can be done by either utilizing the internal signal simulation capability or by applying an external signal source to the "TEST FREQ IN" and "GND" pins.

NOTE
It is not recommended to perform electronics verification while the process is running. If both operations are performed simultaneously, the effect of dual input frequencies may cause error in the electronics verification.
Using a FOUNDATION fieldbus-compliant host, such as the DeltaV System with AMS*inside*, the sensor can be disconnected from the electronics before you begin. The sensor may also be manually disconnected from the electronics as described in "Install the Foundation Fieldbus Electronics Housing" on page 6-11.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please refer to the following safety messages before performing any operation in this section.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Before connecting a FOUNDATION fieldbus-compliant host in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

⚠CAUTION

Remove power before removing the electronics housing.

ELECTRONICS VERIFICATION

Electronics functionality can be verified via two different verification methods:

- Flow Simulation Mode
- Using an External Frequency Generator

Both methods require the use of a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*. It is not required to disconnect the sensor to perform the electronics verification since the transmitter is capable of disconnecting the sensor signal at the input to the electronics. Should the user choose to physically disconnect the sensor from the electronics, refer to "Install the Foundation Fieldbus Electronics Housing" on page 6-11.

Electronics Verification Using Flow Simulation Mode

Electronics verification can be done by utilizing the **SIM-INTERNAL GENERATOR** function. The Model 8800C is capable of simulating either a fixed flow rate or a varying flow rate. The amplitude of the simulated flow signal is based on the minimum required process density for the given line size and service type. Either type of simulation (fixed or varying) will effectively disconnect the Model 8800C sensor from the electronics charge amplifier input (see Figure 6-2 on page 6-4) and replace it with the simulated flow signal.

Fixed Flow Rate Simulation

The fixed flow simulation signal can be entered in either percent of range or flow rate in the current engineering units. The resulting flow rate and/or shedding frequency can be continuously monitored via a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*.

Varying Flow Rate Simulation

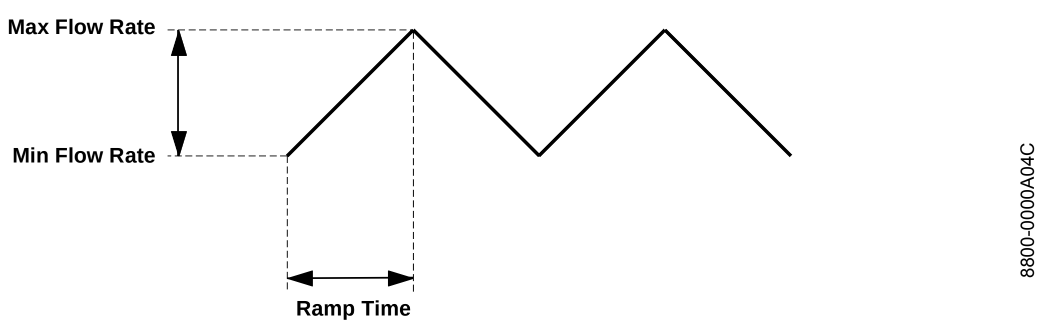
The profile of the varying flow simulation signal is a repetitive triangular waveform as illustrated in Figure 9-1. The minimum and maximum flow rates can be entered in either percent of range or entered as a flow rate in the current engineering units. The ramp time can be entered in seconds from a minimum of 0.533 seconds to a maximum of 34951 seconds. The resulting flow rate and/or shedding frequency can be continuously monitored via a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*.

Exiting Flow Simulation

Use "Sim Disable" to exit the flow simulation mode and return to normal operation mode.

NOTE
To manually disconnect the sensor for precautionary measures, see "Replacing the Sensor" on page 6-12 for details.

Figure 9-1. Profile of Varying Flow Simulation Signal.



Electronics Verification Using an External Frequency Generator

If an external frequency source is desirable, then test points at the top of the electronics are available (see Figure 9-2).

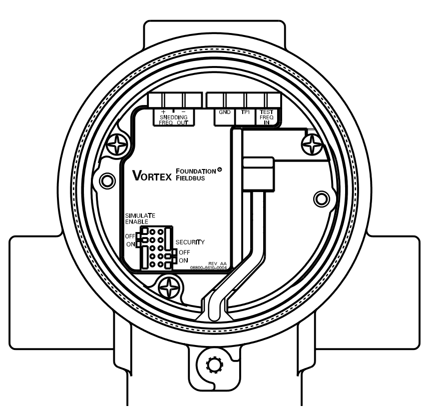
Tools Needed

- FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*
- Standard sinewave generator

1. Remove the electronics compartment cover.
2. Remove the two screws and the LCD indicator if applicable.
3. Connect a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside* to the loop.
4. Access the flow simulation menu on the communicator and select “Sim-External Generator.” This will effectively disconnect the Model 8800C sensor input from the charge amplifier input of the electronics (see Figure 6-2 on page 6-4). The simulated flow and/or the shedding frequency values will now be accessible via a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*.
5. Connect the sinewave generator to the “TEST FREQ IN” and “GND” points as shown in Figure 9-2.
6. Set the sinewave generator amplitude to 2Vpp±10%.
7. Select the desired sinewave generator frequency.
8. Verify the generator frequency against the frequency displayed on a FOUNDATION fieldbus-compliant host, such as DeltaV with AMS*inside*.
9. Select “Sim Disabled” to exit the Flow Simulation Mode.
10. Reconnect the LCD indicator option (if applicable) to the electronics board by replacing and tightening the two screws.
11. Replace and tighten the electronics compartment cover.

NOTE
To manually disconnect the sensor for precautionary measures, see page 6-12 for details.

Figure 9-2. Test Frequency Output and Chassis Ground Points.



8800-0000P03B

Calculating Output Variables with Known Input Frequency

Use the following equations with a known input frequency for verification of a flow rate within a given calibrated range. Select the proper equation depending on whether you are verifying a flow rate or a mass flow rate. Example calculations starting on page 9-7 may clarify how these equations are used.

To Verify a Flow Rate

Perform the following calculation to verify a flow rate for a given frequency and K-factor (compensated).

Conditions:

- Q = flow rate
- F = frequency, measured in Hz
- K = K-factor (compensated)
- C_x = the unit conversion (see Table 9-1 on page 9-6)

Equation:

$$Q = \frac{F}{K \times C_x}$$

To Verify a Standard or Normal Flow Rate

Perform the following calculation to verify a standard or normal flow rate for a given frequency and K-factor (compensated).

Conditions:

- Q = flow rate
- F = frequency, measured in Hz
- K = K-factor (compensated)
- C_x = the unit conversion (see Table 9-1 on page 9-6)

Equation:

$$Q = F \times \frac{Density\ Ratio}{K \times C_x}$$

To Verify a Mass Flow Rate

Perform the following calculation to verify a mass flow rate for a given mass frequency and K-factor (compensated).

Conditions:

- M = flow rate
- F = frequency, measured in Hz
- K = K-factor (compensated)
- ρ = density at operating conditions
- C = the unit conversion

Equation:

$$M = \frac{F}{K/\rho \times C}$$

Conditions:

- C_x = the unit conversion using density (ρ) (see Table 9-1 on page 9-6)

Equation:

$$M = \frac{F}{K \times C_x}$$

User Defined Verification Frequencies

If a larger range of test frequencies is desirable, then use the test points at the top of the electronics board.

1. Remove the LCD cover (if applicable).
2. Remove the two screws and the LCD indicator (if applicable).
3. Unscrew and remove the electronics compartment cover.
4. Remove the sensor from the electronics.
5. Connect the sinewave generator to the **Test Frequency In** and **Chassis Ground** points as shown in Figure 9-2.
6. Set the sinewave generator amplitude to 2Vpp ±10%.
7. Connect a FOUNDATION fieldbus configurator to the loop.
8. Access the AI output of the transmitter on the FOUNDATION fieldbus configurator.
9. Calculate the output frequency using the procedure on page 9-4.
10. Check the shedder frequency on the communicator display, the calculated frequency, and the input frequency at each of the following points: 0%, 25%, 50%, 75%, and 100%.
11. If the frequencies match within ±0.025mA, the output is verified.
12. Reconnect the sensor. Be sure to carefully align the connector before inserting it.
13. Reconnect the LCD indicator option (if applicable) to the electronics board by replacing and tightening the two screws.
14. Replace and tighten the electronics compartment cover.

Unit Conversion Table (User Units to GPS)

Use the following table to assist with calculated frequencies when using user-defined units.

TABLE 9-1. Unit Conversions.

C_x	Units (act)	Conversion Factor
C_1	gal/s	1.00000E+00
C_2	gal/m	1.66667E-02
C_3	gal/h	2.77778E-04
C_4	Impgal/s	1.20095E+00
C_5	Impgal/m	2.00158E-02
C_6	Impgal/h	3.33597E-04
C_7	l/s	2.64172E-01
C_8	l/m	4.40287E-03
C_9	l/h	7.33811E-05
C_{10}	m^3/m	4.40287E-00
C_{11}	m^3/h	7.33811E-02
C_{12}	ft^3/m	1.24675E-01
C_{13}	ft^3/h	2.07792E-03
C_{14}	bbl/h	1.16667E-02
C_{15}	kg/s	$C_{10} \times 60/\rho$
C_{16}	kg/h	C_{11}/ρ
C_{17}	lb/h	C_{13}/ρ
C_{18}	shTon/h	$C_{17} \times 2000$
C_{19}	mTon/h	$C_{16} \times 1000$

ρ*=operating density*

EXAMPLES

The following examples illustrate the calculations that may be necessary for your application. The first set of three examples is in English units. The second set of three examples is in SI units.

Examples: English Units

Example 1 (English Units)

In this application, an input frequency of 75.00 Hz represents a flow rate of 417.1 gpm:

Given:

- Q = flow rate
- F = frequency: 75.00 Hz
- K = K-factor (compensated): 10.79 (via fieldbus configuration tool)
- $C_x = C_2$
  - C_2 = 1.66667E-02 (from Table 9-1 on page 9-6)

Other Conditions:

- Fluid = water
- Line size = 3 in.
- Line pressure = 100 psig
- URV = 500 gal/m
- LRV = 0 gal/m
- Operating temperature = 75 °F

Equation:

$$Q = \frac{F}{K \times C_x}$$

Calculations:

$$Q = \frac{75.00}{10.79 \times 0.0166667}$$

$$Q = 417.1\ gal/m$$

Example 2 (English Units)

In this application, an input frequency of 400.00 Hz represents a flow rate of 19,271.2 lb/h.

Given:

- M = mass flow rate
- F = frequency: 400.00 Hz
- K = K-factor (compensated): 10.678 (via fieldbus configuration tool)
- $C_x = C_{17}$
  - $C_{17} = C_{13}/\rho$ (from Table 9-1 on page 9-6)
- ρ = density: 1.078 lb/ft^3

Other Conditions:

- Fluid = saturated steam
- Line size = 3 in.
- Line pressure = 500 psia
- URV = 40,000 lb/h
- LRV= 0 lb/h
- Operating temperature = 467 °F
- Viscosity = 0.017 cp

Equation:

$$M = \frac{F}{K \times C_x}$$

Calculations:

$$M = \frac{400}{10.678 \times C_{17}}$$

$$M = \frac{400}{10.678 \times (C_{13} / \rho)}$$

$$M = \frac{400}{10.678 \times (0.00207792 / 1.078)}$$

$$M = \frac{400}{10.678 \times 0.0019276}$$

$$M = 19{,}271.2 \text{ lb/h}$$

Examples: SI Units

Example 1 (SI Units)

In this application, an input frequency of 80.00 Hz represents a flow rate of 1,686.8 lpm.

Given:

- Q = flow rate
- F = frequency: 80.00 Hz
- K = K-factor (compensated): 10.772 (via fieldbus configuration tool)
- $C_x = C_8$
    - C_8 = 4.40287E-03 (from Table 9-1 on page 9-6)

Other Conditions:

- Fluid = water
- Line size = 80 mm
- Line pressure = 700 kPag
- URV= 2,000 lpm
- LRV= 0 lpm
- Operating temperature = 60 °C

Equation:

$$Q = \frac{F}{K \times C_x}$$

Calculations:

$$Q = \frac{80.00}{10.772 \times C_8}$$

$$Q = \frac{80.00}{10.772 \times 0.00440287}$$

$$Q = 1{,}686.8\ lpm$$

Example 2 (SI Units)

In this application, an input frequency of 650.00 Hz represents a flow rate of 3,446.4 kg/hr.

Given:
- M = mass flow rate
- F = frequency: 650.00 Hz
- K = K-factor (compensated): 10.715 (via fieldbus configuration tool)
- $C_x = C_{16}$
  - $C_{16} = C_{11}/\rho$ (from Table 9-1 on page 9-6)
- ρ = density: 4.169 lb/m^3 (operating)

Other Conditions:
- Fluid = saturated steam
- Line size = 80 mm
- Line pressure = 700 kPag
- URV = 3,600 kg/h
- LRV = 0 kg/h
- Operating temperature = 170 °C
- Viscosity = 0.015 cp

Equation:

$$M = \frac{F}{K \times C_x}$$

Calculations:

$$M = \frac{650.00}{10.715 \times C_{16}}$$

$$M = \frac{650.00}{10.715 \times (C_{11}/\rho)}$$

$$M = \frac{650.00}{10.715 \times (0.733811/4.169)}$$

$$M = \frac{650.00}{10.715 \times 0.017602}$$

$$M = 3{,}446.4 \text{ kg/h}$$

Appendix A

FOUNDATION™ fieldbus Technology and Fieldbus Function Blocks

OVERVIEW

This section introduces fieldbus systems that are common to all fieldbus devices.

INTRODUCTION

A fieldbus system is a distributed system composed of field devices and control and monitoring equipment integrated into the physical environment of a plant or factory. Fieldbus devices work together to provide I/O and control for automated processes and operations. The Fieldbus Foundation provides a framework for describing these systems as a collection of physical devices interconnected by a fieldbus network. One of the ways that the physical devices are used is to perform their portion of the total system operation by implementing one or more function blocks.

Function Blocks

Function blocks within the fieldbus device perform the various functions required for process control. Because each system is different, the mix and configuration of functions are different. Therefore, the Fieldbus FOUNDATION has designed a range of function blocks, each addressing a different need.

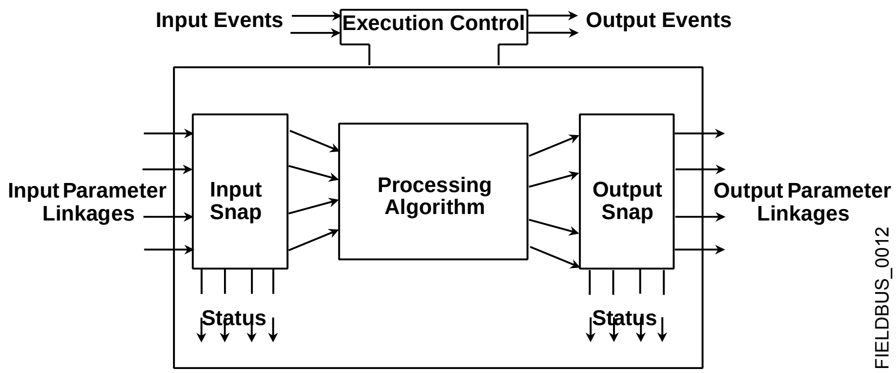
Function blocks perform process control functions, such as analog input (AI) and analog output (AO) functions as well as proportional-integral-derivative (PID) functions. The standard function blocks provide a common structure for defining function block inputs, outputs, control parameters, events, alarms, and modes, and combining them into a process that can be implemented within a single device or over the fieldbus network. This simplifies the identification of characteristics that are common to function blocks.

The Fieldbus FOUNDATION has established the function blocks by defining a small set of parameters used in all function blocks called universal parameters. The FOUNDATION has also defined a standard set of function block classes, such as input, output, control, and calculation blocks. Each of these classes also has a small set of parameters established for it. They have also published definitions for transducer blocks commonly used with standard function blocks. Examples include temperature, pressure, level, and flow transducer blocks.

The FOUNDATION specifications and definitions allow vendors to add their own parameters by importing and subclassing specified classes. This approach permits extending function block definitions as new requirements are discovered and as technology advances.

Figure A-1 illustrates the internal structure of a function block. When execution begins, input parameter values from other blocks are snapped-in by the block. The input snap process ensures that these values do not change during the block execution. New values received for these parameters do not affect the snapped values and will not be used by the function block during the current execution.

Figure A-1. Function Block Internal Structure.



Once the inputs are snapped, the algorithm operates on them, generating outputs as it progresses. Algorithm executions are controlled through the setting of contained parameters. Contained parameters are internal to function blocks and do not appear as normal input and output parameters. However, they may be accessed and modified remotely, as specified by the function block.

Input events may affect the operation of the algorithm. An execution control function regulates the receipt of input events and the generation of output events during execution of the algorithm. Upon completion of the algorithm, the data internal to the block is saved for use in the next execution, and the output data is snapped, releasing it for use by other function blocks.

A block is a tagged logical processing unit. The tag is the name of the block. System management services locate a block by its tag. Thus the service personnel need only know the tag of the block to access or change the appropriate block parameters.

Function blocks are also capable of performing short-term data collection and storage for reviewing their behavior.

Device Descriptions

Device Descriptions are specified tool definitions that are associated with the function blocks. Device descriptions provide for the definition and description of the function blocks and their parameters.

To promote consistency of definition and understanding, descriptive information, such as data type and length, is maintained in the device description. Device Descriptions are written using an open language called the Device Description Language (DDL). Parameter transfers between function blocks can be easily verified because all parameters are described using the same language. Once written, the device description can be stored on an external medium, such as a CD-ROM or diskette. Users can then read the device description from the external medium. The use of an open language in the device description permits interoperability of function blocks within devices from various vendors. Additionally, human interface devices, such as operator consoles and computers, do not have to be programmed specifically for each type of device on the bus. Instead their displays and interactions with devices are driven from the device descriptions.

Device descriptions may also include a set of processing routines called methods. Methods provide a procedure for accessing and manipulating parameters within a device.

BLOCK OPERATION

In addition to function blocks, fieldbus devices contain two other block types to support the function blocks. These are the resource block and the transducer block. The resource block contains the hardware specific characteristics associated with a device. Transducer blocks couple the function blocks to local input/output functions.

Instrument-Specific Function Blocks

Resource Blocks

Resource blocks contain the hardware specific characteristics associated with a device; they have no input or output parameters. The algorithm within a resource block monitors and controls the general operation of the physical device hardware. The execution of this algorithm is dependent on the characteristics of the physical device, as defined by the manufacturer. As a result of this activity, the algorithm may cause the generation of events. There is only one resource block defined for a device. For example, when the mode of a resource block is “out of service,” it impacts all of the other blocks.

Transducer Blocks

Transducer blocks connect function blocks to local input/output functions. They read sensor hardware and write to effector (actuator) hardware. This permits the transducer block to execute as frequently as necessary to obtain good data from sensors and ensure proper writes to the actuator without burdening the function blocks that use the data. The transducer block also isolates the function block from the vendor specific characteristics of the physical I/O.

Alerts

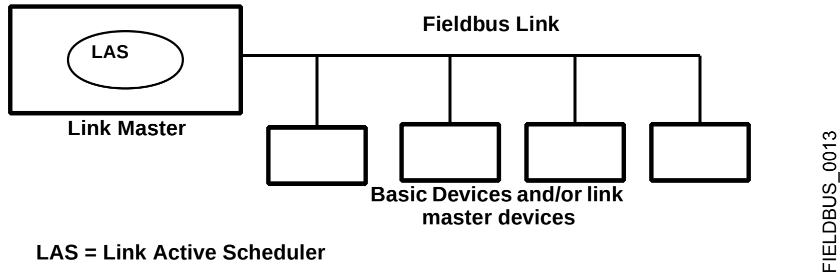
When an alert occurs, execution control sends an event notification and waits a specified period of time for an acknowledgment to be received. This occurs even if the condition that caused the alert no longer exists. If the acknowledgment is not received within the pre-specified time-out period, the event notification is retransmitted. This assures that alert messages are not lost.

Two types of alerts are defined for the block, events and alarms. Events are used to report a status change when a block leaves a particular state, such as when a parameter crosses a threshold. Alarms not only report a status change when a block leaves a particular state, but also report when it returns back to that state.

NETWORK COMMUNICATION

Figure A-2 illustrates a simple fieldbus network consisting of a single segment (link).

Figure A-2. Simple, Single-Link Fieldbus Network.



Link Active Scheduler (LAS)

All links have one and only one Link Active Scheduler (LAS). The LAS operates as the bus arbiter for the link. The LAS does the following:

- recognizes and adds new devices to the link.
- removes non-responsive devices from the link.
- distributes Data Link (DL) and Link Scheduling (LS) time on the link. Data Link Time is a network-wide time periodically distributed by the LAS to synchronize all device clocks on the bus. Link Scheduling time is a link-specific time represented as an offset from Data Link Time. It is used to indicate when the LAS on each link begins and repeats its schedule. It is used by system management to synchronize function block execution with the data transfers scheduled by the LAS.
- polls devices for process loop data at scheduled transmission times.
- distributes a priority-driven token to devices between scheduled transmissions.

Any device on the link may become the LAS, as long as it is capable. The devices that are capable of becoming the LAS are called link master devices. All other devices are referred to as basic devices. When a segment first starts up, or upon failure of the existing LAS, the link master devices on the segment bid to become the LAS. The link master that wins the bid begins operating as the LAS immediately upon completion of the bidding process. Link masters that do not become the LAS act as basic devices. However, the link masters can act as LAS backups by monitoring the link for failure of the LAS and then bidding to become the LAS when a LAS failure is detected.

Only one device can communicate at a time. Permission to communicate on the bus is controlled by a centralized token passed between devices by the LAS. Only the device with the token can communicate. The LAS maintains a list of all devices that need access to the bus. This list is called the “Live List.”

Two types of tokens are used by the LAS. A time-critical token, compel data (CD), is sent by the LAS according to a schedule. A non-time critical token, pass token (PT), is sent by the LAS to each device in ascending numerical order according to address.

Device Addressing

Fieldbus uses addresses between 0 and 255. Addresses 0 through 15 are reserved for group addressing and for use by the data link layer. For all Fisher-Rosemount fieldbus devices addresses 20 through 35 are available to the device. If there are two or more devices with the same address, the first device to start will use its programmed address. Each of the other devices will be given one of four temporary addresses between 248 and 251. If a temporary address is not available, the device will be unavailable until a temporary address becomes available.

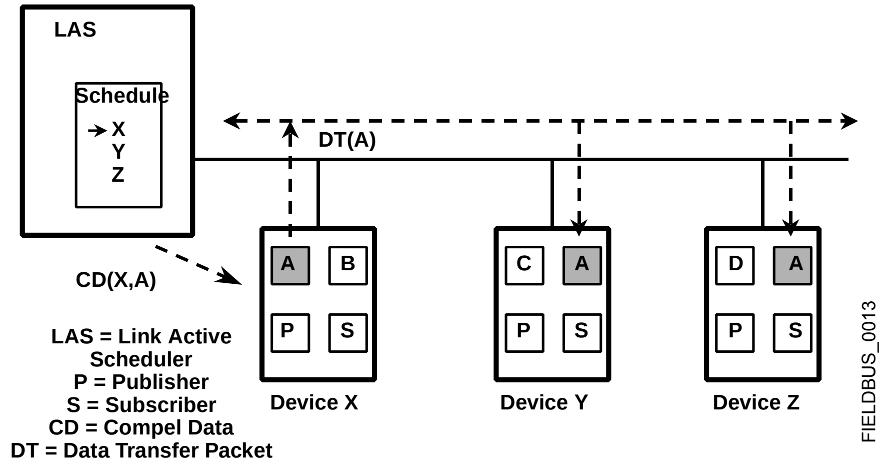
Scheduled Transfers

Information is transferred between devices over the fieldbus using three different types of reporting.

- **Publisher/Subscriber:** This type of reporting is used to transfer critical process loop data, such as the process variable. The data producers (publishers) post the data in a buffer that is transmitted to the subscriber (S), when the publisher receives the Compel data. The buffer contains only one copy of the data. New data completely overwrites previous data. Updates to published data are transferred simultaneously to all subscribers in a single broadcast. Transfers of this type can be scheduled on a precisely periodic basis.
- **Report Distribution:** This type of reporting is used to broadcast and multicast event and trend reports. The destination address may be predefined so that all reports are sent to the same address, or it may be provided separately with each report. Transfers of this type are queued. They are delivered to the receivers in the order transmitted, although there may be gaps due to corrupted transfers. These transfers are unscheduled and occur in between scheduled transfers at a given priority.
- **Client/Server:** This type of reporting is used for request/response exchanges between pairs of devices. Like Report Distribution reporting, the transfers are queued, unscheduled, and prioritized. Queued means the messages are sent and received in the order submitted for transmission, according to their priority, without overwriting previous messages. However, unlike Report Distribution, these transfers are flow controlled and employ a retransmission procedure to recover from corrupted transfers.

Figure A-3 on page A-6 diagrams the method of scheduled data transfer. Scheduled data transfers are typically used for the regular cyclic transfer of process loop data between devices on the fieldbus. Scheduled transfers use publisher/subscriber type of reporting for data transfer. The Link Active Scheduler maintains a list of transmit times for all publishers in all devices that need to be cyclically transmitted. When it is time for a device to publish data, the LAS issues a Compel Data (CD) message to the device. Upon receipt of the CD, the device broadcasts or “publishes” the data to all devices on the fieldbus. Any device that is configured to receive the data is called a “subscriber.”

Figure A-3. Scheduled Data Transfer.

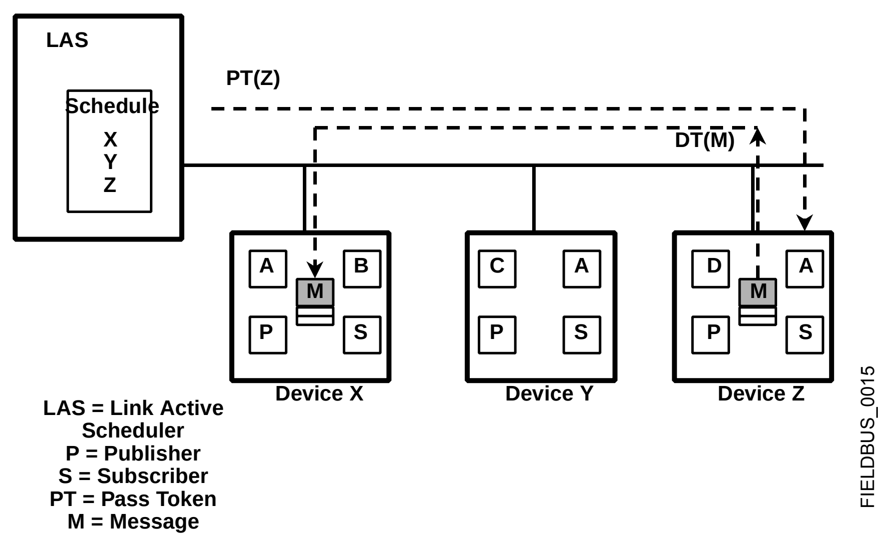


Unscheduled Transfers

Figure A-4 diagrams an unscheduled transfer. Unscheduled transfers are used for things like user-initiated changes, including set point changes, mode changes, tuning changes, and upload/download. Unscheduled transfers use either report distribution or client/server type of reporting for transferring data.

All of the devices on the fieldbus are given a chance to send unscheduled messages between transmissions of scheduled data. The LAS grants permission to a device to use the fieldbus by issuing a pass token (PT) message to the device. When the device receives the PT, it is allowed to send messages until it has finished or until the "maximum token hold time" has expired, whichever is the shorter time. The message may be sent to a single destination or to multiple destinations.

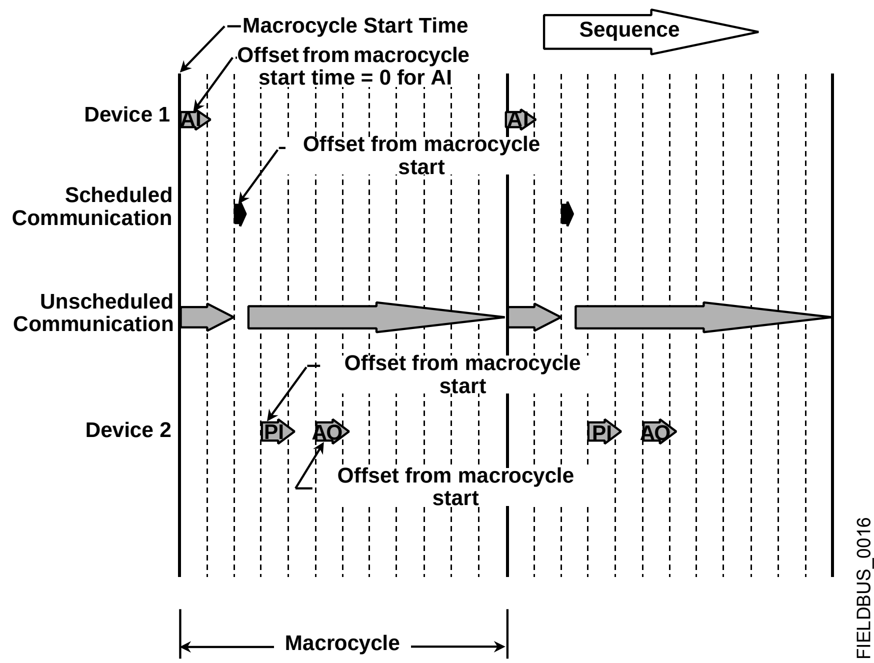
Figure A-4. Unscheduled Data Transfer.



Function Block Scheduling

Figure A-5 shows an example of a link schedule. A single iteration of the link-wide schedule is called the macrocycle. When the system is configured and the function blocks are linked, a master link-wide schedule is created for the LAS. Each device maintains its portion of the link-wide schedule, known as the Function Block Schedule. The Function Block Schedule indicates when the function blocks for the device are to be executed. The scheduled execution time for each function block is represented as an offset from the beginning of the macrocycle start time.

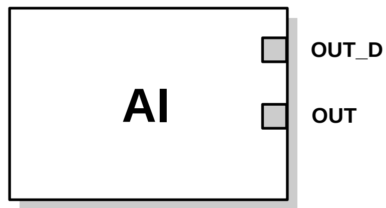
Figure A-5. Example Link Schedule Showing scheduled and Unscheduled Communication.



To support synchronization of schedules, periodically Link Scheduling (LS) time is distributed. The beginning of the macrocycle represents a common starting time for all Function Block schedules on a link and for the LAS link-wide schedule. This permits function block executions and their corresponding data transfers to be synchronized in time.

Appendix

B Analog Input (AI) Function Block



OUT = The block output value and status
OUT_D = Discrete output that signals a selected alarm condition

The Analog Input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes.

The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output parameter (OUT) reflects the process variable (PV) value and status. In Manual mode, OUT may be set manually. The Manual mode is reflected on the output status. A discrete output (OUT_D) is provided to indicate whether a selected alarm condition is active. Alarm detection is based on the OUT value and user specified alarm limits. Figure B-1 on page B-4 illustrates the internal components of the AI function block, and Table B-1 lists the AI block parameters and their units of measure, descriptions, and index numbers.

TABLE B-1. Definitions of Analog Input Function Block System Parameters.

Parameter	Index Number	Units	Description
ACK_OPTION	23	None	Used to set auto acknowledgment of alarms.
ALARM_HYS	24	Percent	The amount the alarm value must return within the alarm limit before the associated active alarm condition clears.
ALARM_SEL	38	None	Used to select the process alarm conditions that will cause the OUT_D parameter to be set.
ALARM_SUM	22	None	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.

TABLE B-1. Definitions of Analog Input Function Block System Parameters.

Parameter	Index Number	Units	Description
BLOCK_ALM	21	None	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	None	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
CHANNEL	15	None	The CHANNEL value is used to select the measurement value. Refer to the appropriate device manual for information about the specific channels available in each device. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
FIELD_VAL	19	Percent	The value and status from the transducer block or from the simulated input when simulation is enabled.
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.
HI_ALM	34	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_ALM	33	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_LIM	26	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_HI_PRI	25	None	The priority of the HI HI alarm.
HI_LIM	28	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.
HI_PRI	27	None	The priority of the HI alarm.
IO_OPTS	13	None	Allows the selection of input/output options used to alter the PV. Low cutoff enabled is the only selectable option.
L_TYPE	16	None	Linearization type. Determines whether the field value is used directly (Direct), is converted linearly (Indirect), or is converted with the square root (Indirect Square Root).
LO_ALM	35	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LIM	30	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_ALM	36	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LO_LIM	32	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
LO_LO_PRI	31	None	The priority of the LO LO alarm.
LO_PRI	29	None	The priority of the LO alarm.
LOW_CUT	17	%	If percentage value of transducer input fails below this, PV = 0.
MODE_BLK	05	None	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
OUT	08	EU of OUT_SCALE	The block output value and status.
OUT_D	37	None	Discrete output to indicate a selected alarm condition.
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
PV	07	EU of XD_SCALE	The process variable used in block execution.
PV_FTIME	18	Seconds	The time constant of the first-order PV filter. It is the time required for a 63% change in the IN value.
SIMULATE	09	None	A group of data that contains the current transducer value and status, the simulated transducer value and status, and the enable/disable bit.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.

TABLE B-1. Definitions of Analog Input Function Block System Parameters.

Parameter	Index Number	Units	Description
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	02	None	The user description of the intended application of the block.
UPDATE_EVT	20	None	This alert is generated by any change to the static data.
VAR_INDEX	39	% of OUT Range	The average absolute error between the PV and its previous mean value over that evaluation time defined by VAR_SCAN.
VAR_SCAN	40	Seconds	The time over which the VAR_INDEX is evaluated.
XD_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the channel input value. The XD_SCALE units code must match the units code of the measurement channel in the transducer block. If the units do not match, the block will not transition to MAN or AUTO

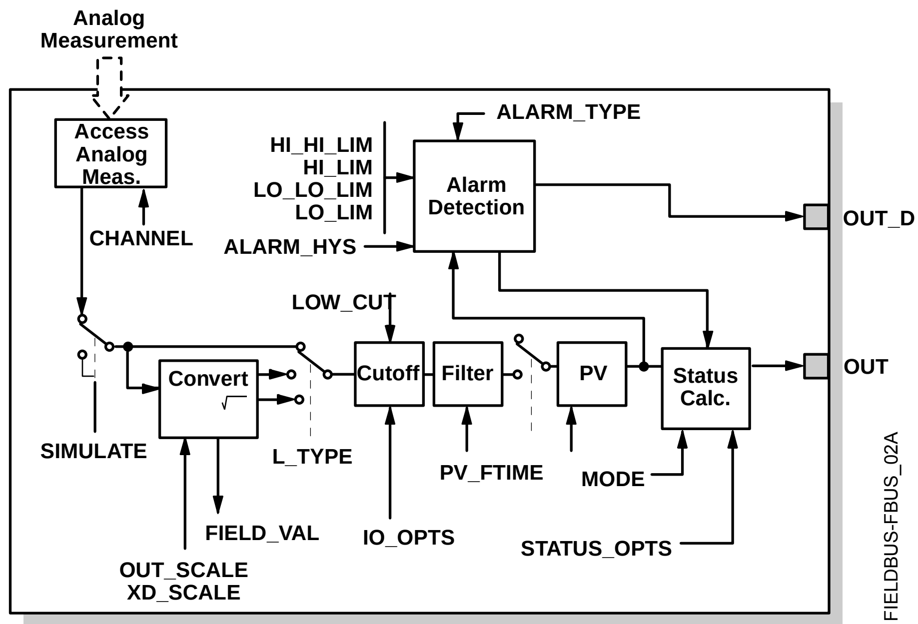
Simulation

To support testing, you can either change the mode of the block to manual and adjust the output value, or you can enable simulation through the configuration tool and manually enter a value for the measurement value and its status. In both cases, you must first set the ENABLE jumper on the field device.

NOTE
All fieldbus instruments have a simulation jumper. As a safety measure, the jumper has to be reset every time there is a power interruption. This measure is to prevent devices that went through simulation in the staging process from being installed with simulation enabled.

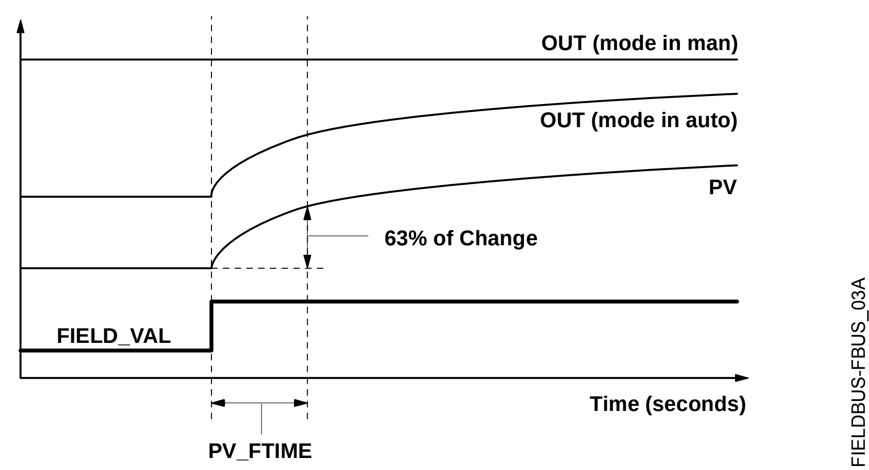
With simulation enabled, the actual measurement value has no impact on the OUT value or the status.

Figure B-1. Analog Input Function Block Schematic.



NOTES:
OUT = block output value and status.
OUT_D = discrete output that signals a selected alarm condition.

Figure B-2. Analog Input Function Block Timing Diagram.



Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can adjust the filter time constant (in seconds) using the PV_FTIME parameter. Set the filter time constant to zero to disable the filter feature.

Signal Conversion

You can set the signal conversion type with the Linearization Type (L_TYPE) parameter. You can view the converted signal (in percent of XD_SCALE) through the FIELD_VAL parameter.

$$\text{FIELD\_VAL} = \frac{100 \times (\text{Channel Value} - \text{EU*@0\%})}{(\text{EU*@100\%} - \text{EU*@0\%})}$$

*** XD_SCALE values**

You can choose from direct, indirect, or indirect square root signal conversion with the L_TYPE parameter.

Direct

Direct signal conversion allows the signal to pass through the accessed channel input value (or the simulated value when simulation is enabled).

$$\text{PV} = \text{Channel Value}$$

Indirect

Indirect signal conversion converts the signal linearly to the accessed channel input value (or the simulated value when simulation is enabled) from its specified range (XD_SCALE) to the range and units of the PV and OUT parameters (OUT_SCALE).

$$\text{PV} = \left(\frac{\text{FIELD\_VAL}}{100}\right) \times (\text{EU**@100\%} - \text{EU**@0\%}) + \text{EU**@0\%}$$

**** OUT_SCALE values**

Indirect Square Root

Indirect Square Root signal conversion takes the square root of the value computed with the indirect signal conversion and scales it to the range and units of the PV and OUT parameters.

$$PV = \sqrt{\left(\frac{FIELD\_VAL}{100}\right)} \times (EU^{**}@100\% - EU^{**}@0\%) + EU^{**}@0\%$$

**** OUT_SCALE values**

When the converted input value is below the limit specified by the LOW_CUT parameter, and the Low Cutoff I/O option (IO_OPTS) is enabled (True), a value of zero is used for the converted value (PV). This option is useful to eliminate false readings when the differential pressure measurement is close to zero, and it may also be useful with zero-based measurement devices such as flowmeters.

NOTE
Low Cutoff is the only I/O option supported by the AI block. You can set the I/O option in **Manual** or **Out of Service** mode only.

Block Errors

Table B-2 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the AI block and are given here only for your reference.

TABLE B-2. BLOCK_ERR Conditions.

Condition Number	Condition Name and Description
0	*Other*
1	**Block Configuration Error:** the selected channel carries a measurement that is incompatible with the engineering units selected in XD_SCALE, the L_TYPE parameter is not configured, or CHANNEL = zero.
2	*Link Configuration Error*
3	**Simulate Active:** Simulation is enabled and the block is using a simulated value in its execution.
4	*Local Override*
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	**Input Failure/Process Variable has Bad Status:** The hardware is bad, or a bad status is being simulated.
8	**Output Failure:** The output is bad based primarily upon a bad input.
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*
13	*Device Needs Maintenance Now*
14	*Power Up*
15	**Out of Service:** The actual mode is out of service.

Modes

The AI Function Block supports three modes of operation as defined by the MODE_BLK parameter:

- **Manual (Man)** The block output (OUT) may be set manually
- **Automatic (Auto)** OUT reflects the analog input measurement or the simulated value when simulation is enabled.

- **Out of Service (O/S)** The block is not processed. FIELD_VAL and PV are not updated and the OUT status is set to Bad: Out of Service. The BLOCK_ERR parameter shows Out of Service. In this mode, you can make changes to all configurable parameters. The target mode of a block may be restricted to one or more of the supported modes.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined above.

Process Alarm detection is based on the OUT value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI

Alarms are grouped into five levels of priority:

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

Normally, the status of the PV reflects the status of the measurement value, the operating condition of the I/O card, and any active alarm condition. In Auto mode, OUT reflects the value and status quality of the PV. In Man mode, the OUT status constant limit is set to indicate that the value is a constant and the OUT status is *Good*.

The **Uncertain** - EU range violation status is always set, and the PV status is set high- or low-limited if the sensor limits for conversion are exceeded.

In the STATUS_OPTS parameter, you can select from the following options to control the status handling:

BAD if Limited – sets the OUT status quality to *Bad* when the value is higher or lower than the sensor limits.

Uncertain if Limited – sets the OUT status quality to *Uncertain* when the value is higher or lower than the sensor limits.

Uncertain if in Manual mode – The status of the Output is set to *Uncertain* when the mode is set to Manual

NOTES
1. The instrument must be in **Manual** or **Out of Service** mode to set the status option.
2. The AI block only supports the **BAD if Limited** option. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Advanced Features

The AI function block provided with Fisher-Rosemount fieldbus devices provides added capability through the addition of the following parameters:

ALARM_TYPE – Allows one or more of the process alarm conditions detected by the AI function block to be used in setting its OUT_D parameter.

OUT_D – Discrete output of the AI function block based on the detection of process alarm condition(s). This parameter may be linked to other function blocks that require a discrete input based on the detected alarm condition.

VAR_SCAN – Time period in seconds over which the variability index (VAR_INDEX) is computed.

VAR_INDEX – Process variability index measured as the integral of average absolute error between PV and its mean value over the previous evaluation period. This index is calculated as a percent of OUT span and is updated at the end of the time period defined by VAR_SCAN.

Application Information

The configuration of the AI function block and its associated output channels depends on the specific application. A typical configuration for the AI block involves the following parameters:

CHANNEL If the device supports more than one measurement, verify that the selected channel contains the appropriate measurement or derived value.

L_TYPE Select **Direct** when the measurement is already in the engineering units that you want for the block output.

Select **Indirect** when you want to convert the measured variable into another, for example, pressure into level or flow into energy.

Select **Indirect Square Root** when the block I/O parameter value represents a flow measurement made using differential pressure, and when square root extraction is not performed by the transducer.

SCALING **XD_SCALE** provides the range and units of the measurement and **OUT_SCALE** provides the range and engineering units of the output.

Application Example: Temperature Transmitter

Situation

A temperature transmitter with a range of –200 to 450 °C.

Solution

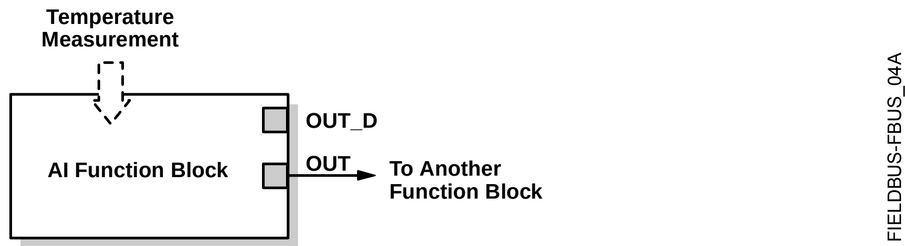
Table B-3 lists the appropriate configuration settings, and Figure B-3 illustrates the correct function block configuration.

.

TABLE B-3. Analog Input Function Block Configuration for a Typical Temperature Transmitter.

Parameter	Configured Values
L_TYPE	Direct
XD_SCALE	Not Used
OUT_SCALE	Not Used

Figure B-3. Analog Input Function Block Diagram for a Typical Temperature Transmitter.

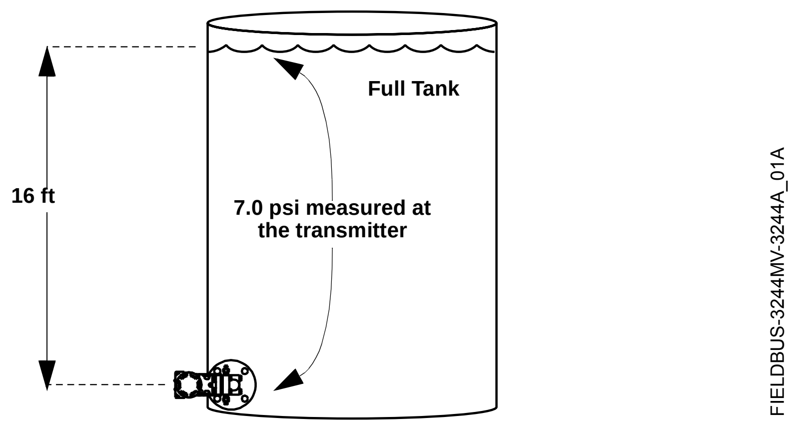


Application Example: Pressure Transmitter used to Measure Level in an Open Tank

Situation #1

The level of an open tank is to be measured using a pressure tap at the bottom of the tank. The level measurement will be used to control the level of liquid in the tank. The maximum level at the tank is 16 ft. The liquid in the tank has a density that makes the level correspond to a pressure of 7.0 psi at the pressure tap (see Figure B-4).

Figure B-4. Situation #1 Diagram.



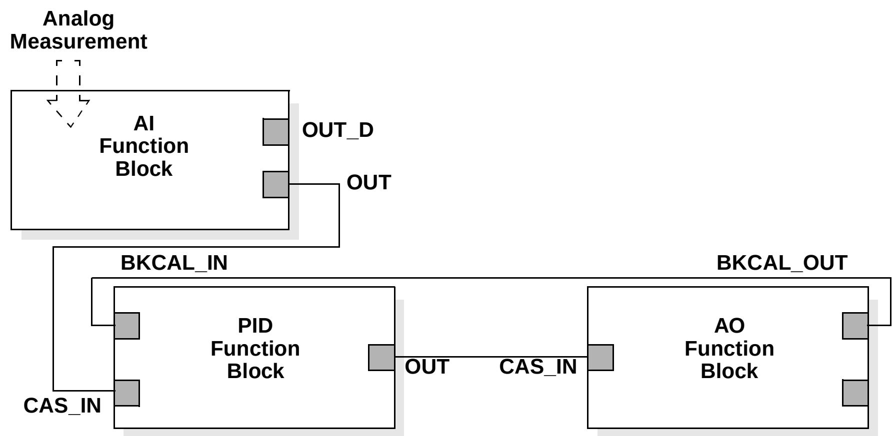
Solution to Situation #1

Table B-4 lists the appropriate configuration settings, and Figure B-5 illustrates the correct function block configuration.

TABLE B-4. Analog Input Function Block Configuration for a Pressure Transmitter used in Level Measurement (situation #1).

Parameter	Configured Values
L_TYPE	Indirect
XD_SCALE	0 to 7 psi
OUT_SCALE	0 to 16 ft

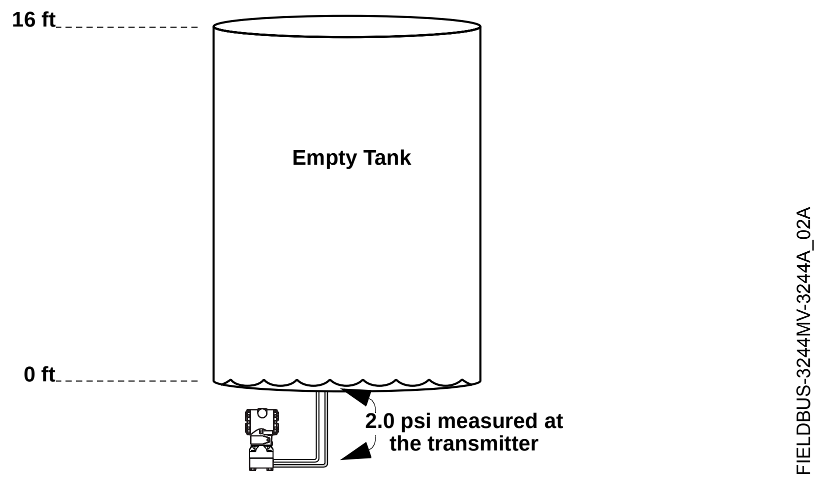
Figure B-5. Function Block Diagram for a Pressure Transmitter used in Level Measurement.



Situation #2

The transmitter in situation #1 is installed below the tank in a position where the liquid column in the impulse line, when the tank is empty, is equivalent to 2.0 psi (see Figure B-6).

Figure B-6. Situation #2 Diagram.



Solution

Table B-5 lists the appropriate configuration settings.

TABLE B-5. Analog Input Function Block Configuration for a Pressure Transmitter used in Level Measurement (Situation #2).

Parameter	Configured Values
L_TYPE	Indirect
XD_SCALE	2 to 9 psi
OUT_SCALE	0 to 16 ft

Application Example: Differential Pressure Transmitter to Measure Flow

Situation

The liquid flow in a line is to be measured using the differential pressure across an orifice plate in the line, and the flow measurement will be used in a flow control loop. Based on the orifice specification sheet, the differential pressure transmitter was calibrated for 0 to 20 in H_20 for a flow of 0 to 800 gal/min, and the transducer was not configured to take the square root of the differential pressure.

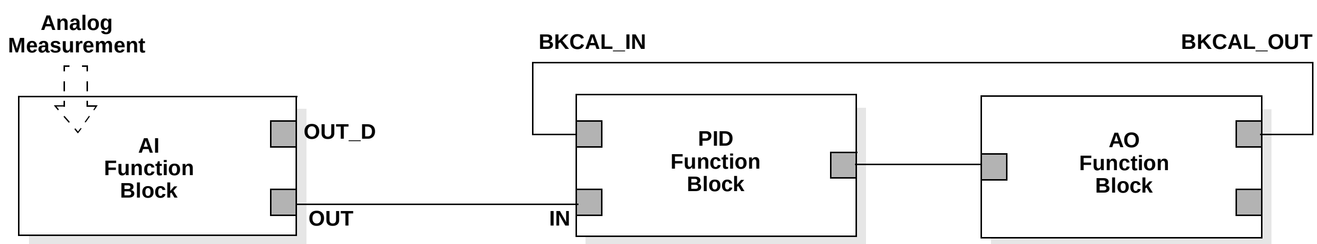
Solution

Table B-6 lists the appropriate configuration settings, and Figure B-7 illustrates the correct function block configuration.

TABLE B-6. Analog Input Function Block Configuration for a Differential Pressure Transmitter.

Parameter	Configured Values
L_TYPE	Indirect Square Root
XD_SCALE	0 to 20 in.
OUT_SCALE	0 to 800 gal/min.

Figure B-7. Function Block Diagram for a Differential Pressure Transmitter Used in a Flow Measurement.



Troubleshooting

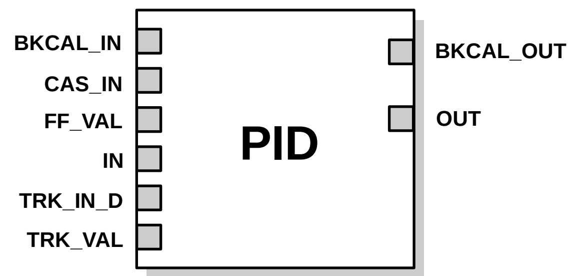
Refer to Table B-7 to troubleshoot any problems that you encounter.

TABLE B-7. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	Target mode not set.	Set target mode to something other than OOS.
	Configuration error	BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: • CHANNEL must be set to a valid value and cannot be left at initial value of 0. • XD_SCALE.UNITS_INDX must match the units in the transducer block channel value. • L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	Resource block	The actual mode of the Resource block is OOS. See Resource Block Diagnostics for corrective action.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Process and/or block alarms will not work.	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status Options	STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.
Value of output does not make sense	Linearization Type	L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	Scaling	Scaling parameters are set incorrectly: • XD_SCALE.EU0 and EU100 should match that of the transducer block channel value. • OUT_SCALE.EU0 and EU100 are not set properly.
Cannot set HI_LIMIT, HI_HI_LIMIT, LO_LIMIT, or LO_LO_LIMIT Values	Scaling	Limit values are outside the OUT_SCALE.EU0 and OUT_SCALE.EU100 values. Change OUT_SCALE or set values within range.

Appendix C

PID Function Block



BKCAL_IN = The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bumpless transfer and to pass limit status.

CAS_IN = The remote setpoint value from another function block.

FF_VAL = The feedforward control input value and status.

IN = The connection for the process variable from another function block.

TRK_IN_D = Initiates the external tracking function.

TRK_VAL = The value after scaling applied to OUT in Local Override mode.

BKCAL_OUT = The value and status required by the BKCAL_IN input of another function block to prevent reset windup and to provide bumpless transfer to closed loop control.

OUT = The block output and status.

The PID function block combines all of the necessary logic to perform proportional/integral/derivative (PID) control. The block supports mode control, signal scaling and limiting, feedforward control, override tracking, alarm limit detection, and signal status propagation.

The block supports two forms of the PID equation: Standard and Series. You can choose the appropriate equation using the FORM parameter. The Standard ISA PID equation is the default selection.

$$\text{Standard Out} = \text{GAIN} \times e \times \left(1 + \frac{1}{\tau_r s + 1} + \frac{\tau_d s}{\alpha \times \tau_d s + 1}\right) + F$$

$$\text{Series Out} = \text{GAIN} \times e \times \left[\left(1 + \frac{1}{\tau_r s}\right) + \left(\frac{\tau_d s + 1}{\alpha \times \tau_d s + 1}\right)\right] + F$$

Where

GAIN: proportional gain value
τ_r: integral action time constant (RESET parameter) in seconds
s: laplace operator
τ_d: derivative action time constant (RATE parameter)
α: fixed smoothing factor of 0.1 applied to RATE
F: feedforward control contribution from the feedforward input (FF_VAL parameter)
e: error between setpoint and process variable

To further customize the block for use in your application, you can configure filtering, feedforward inputs, tracking inputs, setpoint and output limiting, PID equation structures, and block output action. Table C-1 lists the PID block parameters and their descriptions, units of measure, and index numbers, and Figure C-1 on page C-5 illustrates the internal components of the PID function block.

TABLE C-1. PID Function Block System Parameters.

Parameter	Index Number	Units	Description
ACK_OPTION	46	None	Used to set auto acknowledgment of alarms.
ALARM_HYS	47	Percent	The amount the alarm value must return to within the alarm limit before the associated active alarm condition clears.
ALARM_SUM	45	None	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
ALG_TYPE	74	None	Selects filtering algorithm as Backward or Bilinear.
BAL_TIME	25	Seconds	The specified time for the internal working value of bias to return to the operator set bias. Also used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is AUTO, CAS, or RCAS.
BIAS	66	EU of OUT_SCALE	The bias value used to calculate output for a PD type controller.
BKCAL_HYS	30	Percent	The amount the output value must change away from the its output limit before limit status is turned off.
BKCAL_IN	27	EU of OUT_SCALE	The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bumpless transfer and to pass limit status.
BKCAL_OUT	31	EU of PV_SCALE	The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bumpless transfer of closed loop control.
BLOCK_ALM	44	None	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the active status in the status parameter. As soon as the Unreported status is cleared by the alert reporting task, and other block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	None	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string so that multiple errors may be shown.
BYPASS	17	None	Used to override the calculation of the block. When enabled, the SP is sent directly to the output.
CAS_IN	18	EU of PV_SCALE	The remote setpoint value from another block.
CONTROL_OPTS	13	None	Allows you to specify control strategy options. The supported control options for the PID block are Track enable, Track in Manual, SP-PV Track in Man, SP-PV Track in LO or IMAN, Use PV for BKCAL_OUT, and Direct Acting
DV_HI_ALM	64	None	The DV HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_HI_LIM	57	EU of PV_SCALE	The setting for the alarm limit used to detect the deviation high alarm condition.
DV_HI_PRI	56	None	The priority of the deviation high alarm.
DV_LO_ALM	65	None	The DV LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_LO_LIM	59	EU of PV_SCALE	The setting for the alarm limit use to detect the deviation low alarm condition.
DV_LO_PRI	58	None	The priority of the deviation low alarm.
ERROR	67	EU of PV_SCALE	The error (SP-PV) used to determine the control action.
FF_ENABLE	70	None	Enables the use of feedforward calculations
FF_GAIN	42	None	The feedforward gain value. FF_VAL is multiplied by FF_GAIN before it is added to the calculated control output.

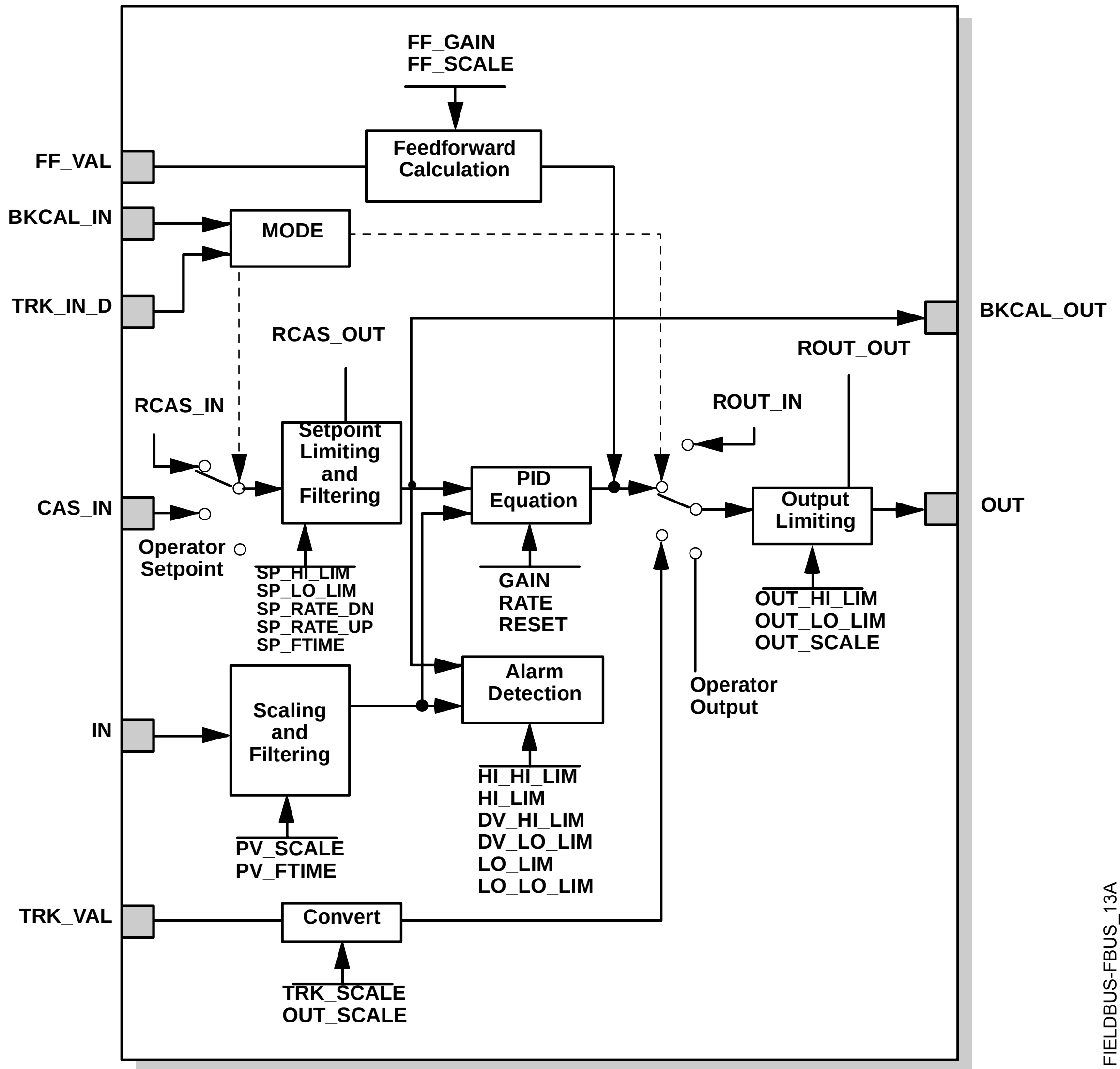
TABLE C-1. PID Function Block System Parameters.

Parameter	Index Number	Units	Description
FF_SCALE	41	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the feedforward value (FF_VAL).
FF_VAL	40	EU of FF_SCALE	The feedforward control input value and status.
GAIN	23	None	The proportional gain value. This value cannot = 0.
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by the device.
HI_ALM	61	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
HI_HI_ALM	60	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
HI_HI-LIM	49	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_HI_PRI	48	None	The priority of the HI HI Alarm.
HI_LIM	51	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.
HI_PRI	50	None	The priority of the HI alarm.
IN	15	EU of PV_SCALE	The connection for the PV input from another block.
LO_ALM	62	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_LIM	53	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_ALM	63	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_LO_LIM	55	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
LO_LO_PRI	54	None	The priority of the LO LO alarm.
LO_PRI	52	None	The priority of the LO alarm.
MATH_FORM	73	None	Selects equation form (series or standard).
MODE_BLK	05	None	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
OUT	09	EU of OUT_SCALE	The block input value and status.
OUT_HI_LIM	28	EU of OUT_SCALE	The maximum output value allowed.
OUT-LO_LIM	29	EU of OUT_SCALE	The minimum output value allowed
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
PV	07	EU of PV_SCALE	The process variable used in block execution.
PV_FTIME	16	Seconds	The time constant of the first-order PV filter. It is the time required for a 63 percent change in the IN value.
PV_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with PV.
RATE	26	Seconds	The derivative action time constant.
RCAS_IN	32	EU of PV_SCALE	Target setpoint and status that is provided by a supervisory host. Used when mode is RCAS.
RCAS_OUT	35	EU of PV_SCALE	Block setpoint and status after ramping, filtering, and limiting that is provided to a supervisory host for back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
RESET	24	Seconds per repeat	The integral action time constant.
ROUT_IN	33	EU of OUT_SCALE	Target output and status that is provided by a supervisory host. Used when mode is ROUT.
ROUT_OUT	36	EU of OUT_SCALE	Block output that is provided to a supervisory host for a back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
SHED_OPT	34	None	Defines action to be taken on remote control device timeout.
SP	08	EU of PV_SCALE	The target block setpoint value. It is the result of setpoint limiting and setpoint rate of change limiting.

TABLE C-1. PID Function Block System Parameters.

Parameter	Index Number	Units	Description
SP_FTIME	69	Seconds	The time constant of the first-order SP filter. It is the time required for a 63 percent change in the IN value.
SP_HI_LIM	21	EU of PV_SCALE	The highest SP value allowed.
SP_LO_LIM	22	EU of PV_SCALE	The lowest SP value allowed.
SP_RATE_DN	19	EU of PV_SCALE per second	Ramp rate for downward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP-RATE_UP	20	EU of PV_SCALE per second	Ramp rate for upward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP_WORK	68	EU of PV_SCALE	The working setpoint of the block after limiting and filtering is applied.
STATUS_OPTS	14	None	Allows you to select options for status handling and processing. The supported status option for the PID block is Target to Manual if Bad IN.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
STRUCTURE. CONFIG	75	None	Defines PID equation structure to apply controller action.
TAG_DESC	02	None	The user description of the intended application of the block.
TRK_IN_D	38	None	Discrete input that initiates external tracking.
TRK_SCALE	37	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the external tracking value (TRK_VAL).
TRK_VAL	39	EU of TRK_SCALE	The value (after scaling from TRK_SCALE to OUT_SCALE) APPLIED to OUT in LO mode.
UBETA	72	Percent	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID.
UGAMMA	71	Percent	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID.
UPDATE_EVT	43	None	This alert is generated by any changes to the static data.

Figure C-1. PID Function Block Schematic.



Setpoint Selection and Limiting

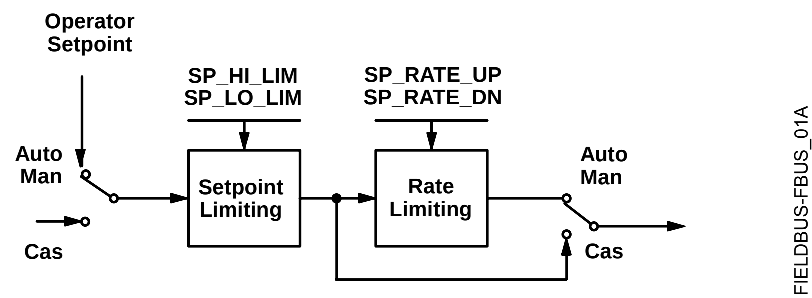
The setpoint of the PID block is determined by the mode. You can configure the SP_HI_LIM and SP_LO_LIM parameters to limit the setpoint. In **Cascade** or **RemoteCascade** mode, the setpoint is adjusted by another function block or by a host computer, and the output is computed based on the setpoint.

In **Automatic** mode, the setpoint is entered manually by the operator, and the output is computed based on the setpoint. In Auto mode, you can also adjust the setpoint limit and the setpoint rate of change using the SP_RATE_UP and SP_RATE_DN parameters.

In **Manual** mode the output is entered manually by the operator, and is independent of the setpoint. In **RemoteOutput** mode, the output is entered by a host computer, and is independent of the setpoint.

Figure C-2 illustrates the method for setpoint selection.

Figure C-2. PID Function Block Setpoint Selection.



Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can configure the filtering feature with the FILTER_TYPE parameter, and you can adjust the filter time constant (in seconds) using the PV_FTIME or SP_FTIME parameters. Set the filter time constant to zero to disable the filter feature.

Feedforward Calculation

The feedforward value (FF_VAL) is scaled (FF_SCALE) to a common range for compatibility with the output scale (OUT_SCALE). A gain value (FF_GAIN) is applied to achieve the total feedforward contribution.

Tracking

You enable the use of output tracking through the control options. You can set control options in Manual or Out of Service mode only.

The **Track Enable** control option must be set to *True* for the track function to operate. When the Track in Manual control option is set to *True*, tracking can be activated and maintained only when the block is in **Manual** mode. When **Track in Manual** is *False*, the operator can override the tracking function when the block is in **Manual** mode. Activating the track function causes the block's actual mode to revert to **Local Override**.

The TRK_VAL parameter specifies the value to be converted and tracked into the output when the track function is operating. The TRK_SCALE parameter specifies the range of TRK_VAL.

When the TRK_IN_D parameter is *True* and the **Track Enable** control option is *True*, the TRK_VAL input is converted to the appropriate value and output in units of OUT_SCALE.

Output Selection and Limiting

Output selection is determined by the mode and the setpoint. In **Automatic**, **Cascade**, or **RemoteCascade** mode, the output is computed by the PID control equation. In **Manual** and **RemoteOutput** mode, the output may be entered manually (see also “Setpoint Selection and Limiting” on page C-6). You can limit the output by configuring the OUT_HI_LIM and OUT_LO_LIM parameters.

Bumpless Transfer and Setpoint Tracking

You can configure the method for tracking the setpoint by configuring the following control options (CONTROL_OPTS):

SP-PV Track in Man — Permits the SP to track the PV when the target mode of the block is Man.

SP-PV Track in LO or IMan — Permits the SP to track the PV when the actual mode of the block is Local Override (LO) or Initialization Manual (IMan).

When one of these options is set, the SP value is set to the PV value while in the specified mode.

You can select the value that a master controller uses for tracking by configuring the **Use PV for BKCAL_OUT** control option. The BKCAL_OUT value tracks the PV value. BKCAL_IN on a master controller connected to BKCAL_OUT on the PID block in an open cascade strategy forces its OUT to match BKCAL_IN, thus tracking the PV from the slave PID block into its cascade input connection (CAS_IN). If the **Use PV for BKCAL_OUT** option is not selected, the working setpoint (SP_WRK) is used for BKCAL_OUT.

You can set control options in **Manual** or **Out of Service** mode only. When the mode is set to **Auto**, the SP will remain at the last value (it will no longer follow the PV.

PID Equation Structures

Configure the STRUCTURE parameter to select the PID equation structure. You can select one of the following choices:

- PI Action on Error, D Action on PV
- PID Action on Error
- I Action on Error, PD Action on PV

Set RESET to zero to configure the PID block to perform integral only control regardless of the STRUCTURE parameter selection. When RESET equals zero, the equation reduces to an integrator equation with a gain value applied to the error:

$$\frac{GAIN \times e(s)}{s}$$

Where

GAIN: proportional gain value
e: error
s: laplace operator

Reverse and Direct Action

To configure the block output action, enable the **Direct Acting** control option. This option defines the relationship between a change in PV and the corresponding change in output. With **Direct Acting** enabled (True), an increase in PV results in an increase in the output.

You can set control options in **Manual** or **Out of Service** mode only.

NOTE
Track Enable, **Track in Manual**, **SP-PV Track in Man**, **SP-PV Track in LO or IMan**, **Use PV for BKCAL_OUT**, and **Direct Acting** are the only control options supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Reset Limiting

The PID function block provides a modified version of feedback reset limiting that prevents windup when output or input limits are encountered, and provides the proper behavior in selector applications.

Block Errors

Table C-2 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the PID block and are given here only for your reference.

TABLE C-2. BLOCK_ERR Conditions.

Condition Number	Condition Name and Description
0	*Other*
1	**Block Configuration Error:** The BY_PASS parameter is not configured and is set to 0, the SP_HI_LIM is less than the SP_LO_LIM, or the OUT_HI_LIM is less than the OUT_LO_LIM.
2	*Link Configuration Error*
3	*Simulate Active*
4	**Local Override**: The actual mode is LO.
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	**Input Failure/Process Variable has Bad Status:** The parameter linked to IN is indicating a Bad status.
8	*Output Failure*
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*
13	*Device Needs Maintenance Now*
14	*Power Up*
15	**Out of Service:** The actual mode is out of service.

Modes

The PID function block supports the following modes:

Manual (Man)—The block output (OUT) may be set manually.

Automatic (Auto)—The SP may be set manually and the block algorithm calculates OUT.

Cascade (Cas)—The SP is calculated in another block and is provided to the PID block through the CAS_IN connection.

RemoteCascade (RCas)—The SP is provided by a host computer that writes to the RCAS_IN parameter.

RemoteOutput (Rout)—The OUT IS provided by a host computer that writes to the ROUT_IN parameter

Local Override (LO)—The track function is active. OUT is set by TRK_VAL. The BLOCK_ERR parameter shows Local override.

Initialization Manual (IMan)—The output path is not complete (for example, the cascade-to-slave path might not be open). In IMan mode, OUT tracks BKCAL_IN.

Out of Service (O/S)—The block is not processed. The OUT status is set to *Bad: Out of Service*. The BLOCK_ERR parameter shows Out of service.

You can configure the Man, Auto, Cas, and O/S modes as permitted modes for operator entry.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined above.

Process alarm detection is based on the PV value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

Additional process alarm detection is based on the difference between SP and PV values and can be configured via the following parameters:

- Deviation high (DV_HI_LIM)
- Deviation low (DV_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI
- DV_HI_PRI
- DV_LO_PRI

Alarms are grouped into five levels of priority:

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

If the input status on the PID block is *Bad*, the mode of the block reverts to **Manual**. In addition, you can select the **Target to Manual if Bad IN** status option to direct the target mode to revert to manual. You can set the status option in **Manual** or **Out of Service** mode only.

NOTE
Target to Manual if Bad IN is the only status option supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Application Information

The PID function block is a powerful, flexible control algorithm that is designed to work in a variety of control strategies. The PID block is configured differently for different applications. The following examples describe the use of the PID block for closed-loop control (basic PID loop), feedforward control, cascade control with master and slave, and complex cascade control with override.

Closed Loop Control

To implement basic closed loop control, compute the error difference between the process variable (PV) and setpoint (SP) values and calculate a control output signal using a PID (Proportional Integral Derivative) function block.

The proportional control function responds immediately and directly to a change in the PV or SP. The proportional term **GAIN** applies a change in the loop output based on the current magnitude of the error multiplied by a gain value.

The integral control function reduces the process error by moving the output in the appropriate direction. The integral term **RESET** applies a correction based on the magnitude and duration of the error. Set the RESET parameter to zero for integral-only control. To reduce reset action, configure the RESET parameter to be a large value.

The derivative term **RATE** applies a correction based on the anticipated change in error. Derivative control is typically used in temperature control where large measurement lags exist.

The MODE parameter is a switch that indicates the target and actual mode of operation. Mode selection has a large impact on the operation of the PID block:

- **Manual** mode allows the operator to set the value of the loop output signal directly.
- **Automatic** mode allows the operator to select a setpoint for automatic correction of error using the **GAIN**, **RESET**, and **RATE** tuning values.
- **Cascade** and **Remote Cascade** modes use a setpoint from another block in a cascaded configuration.
- **Remote Out** mode is similar to **Manual** mode except that the block output is supplied by an external program rather than by the operator.
- **Initialization Manual** is a non-target mode used with cascade configurations while transitioning from manual operation to automatic operation.
- **Local Override** is a non-target mode that instructs the block to revert to Local Override when the tracking or fail-safe control options are activated.
- **Out of Service** mode disables the block for maintenance.

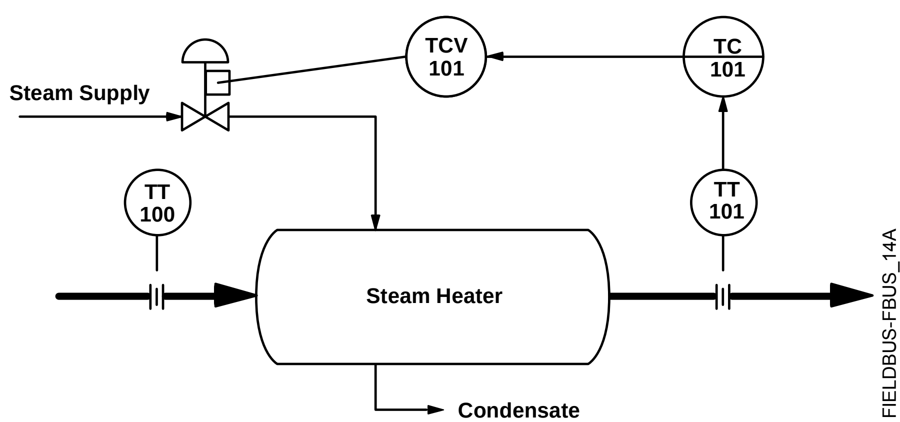
Abrupt changes in the quality of the input signal can result in unexpected loop behavior. To prevent the output from changing abruptly and upsetting the process, select the **SP-PV Track in Man** I/O option. This option automatically sets the loop to **Manual** if a *Bad* input status is detected. While in manual mode, the operator can manage control manually until a *Good* input status is reestablished.

Application Example: Basic PID Block for Steam Heater Control

Situation

A PID block is used with an AI block and an AO block to control the flow steam used to heat a process fluid in a heat exchanger. Figure C-3 illustrates the process instrumentation diagram.

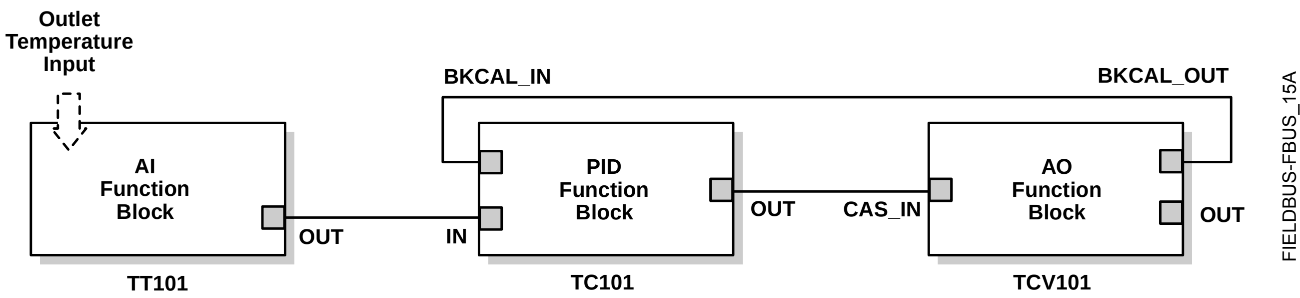
Figure C-3. PID Function Block Steam Heater Control Example.



Solution

The PID loop uses TT101 as an input and provides a signal to the analog output TCV101. The BKCAL_OUT of the AO block and the BKCAL_IN of the PID block communicate the status and quality of information being passed between the blocks. The status indication shows that communications is functioning and the I/O is working properly. Figure C-4 illustrates the correct function block configuration.

Figure C-4. PID Function Block Diagram for Steam Heater Control Example.



Application Example: Feedforward Control

Situation

In the previous example, control problems can arise because of a time delay caused by thermal inertia between the two flow streams (TT100 and TT101). Variations in the inlet temperature (TT100) take an excessive amount of time to be sensed in the outlet (TT101). This delay causes the product to be out of the desired temperature range.

Solution

Feedforward control is added to improve the response time of the basic PID control. The temperature of the inlet process fluid (TT100) is input to an AI function block and is connected to the FF_VAL connector on the PID block. Feedforward control is then enabled (FF_ENABLE), the feedforward value is scaled (FF_SCALE), and a gain (FF_GAIN) is determined. Figure C-5 illustrates the process instrumentation diagram, and Figure C-6 illustrates the correct function block configuration.

Figure C-5. PID Function Block Feedforward Control Example.

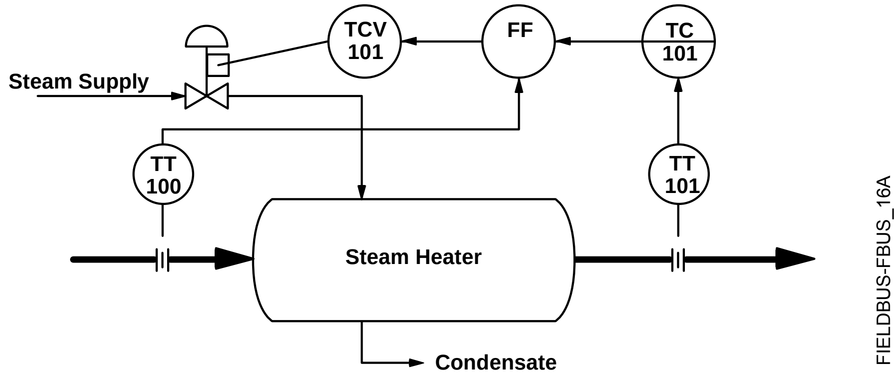
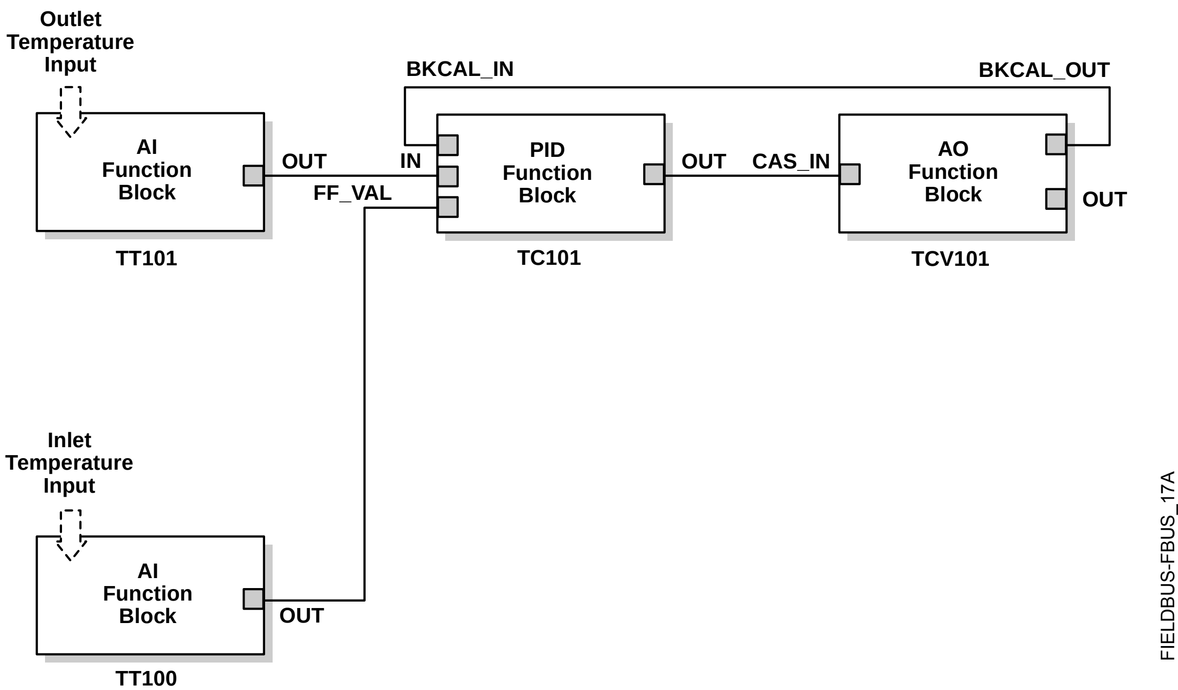


Figure C-6. Function Block Diagram for Feedforward Control.

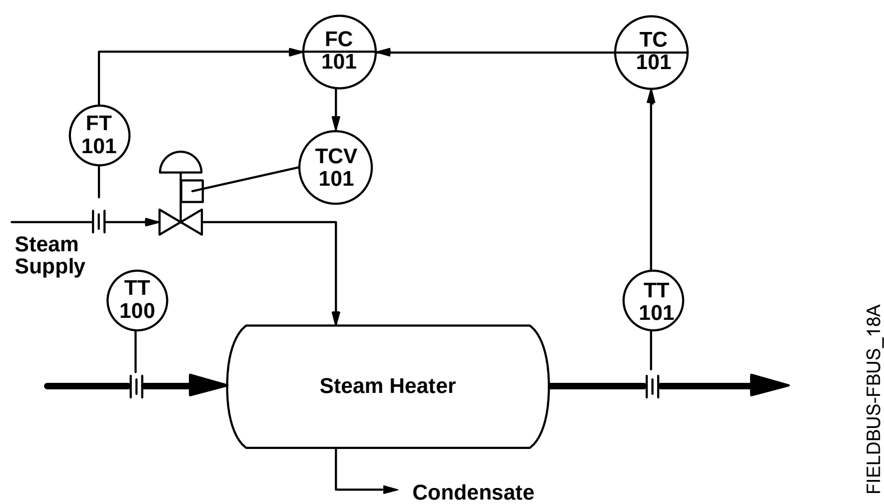


Application Example: Cascade Control with Master and Slave Loops

Situation

A slave loop is added to a basic PID control configuration to measure and control steam flow to the steam heater. Variations in the steam pressure cause the temperature in the heat exchanger to change. The temperature variation will later be sensed by TT101. The temperature controller will modify the valve position to compensate for the steam pressure change. The process is slow and causes variations in the product temperature. Figure C-7 illustrates the process instrumentation diagram.

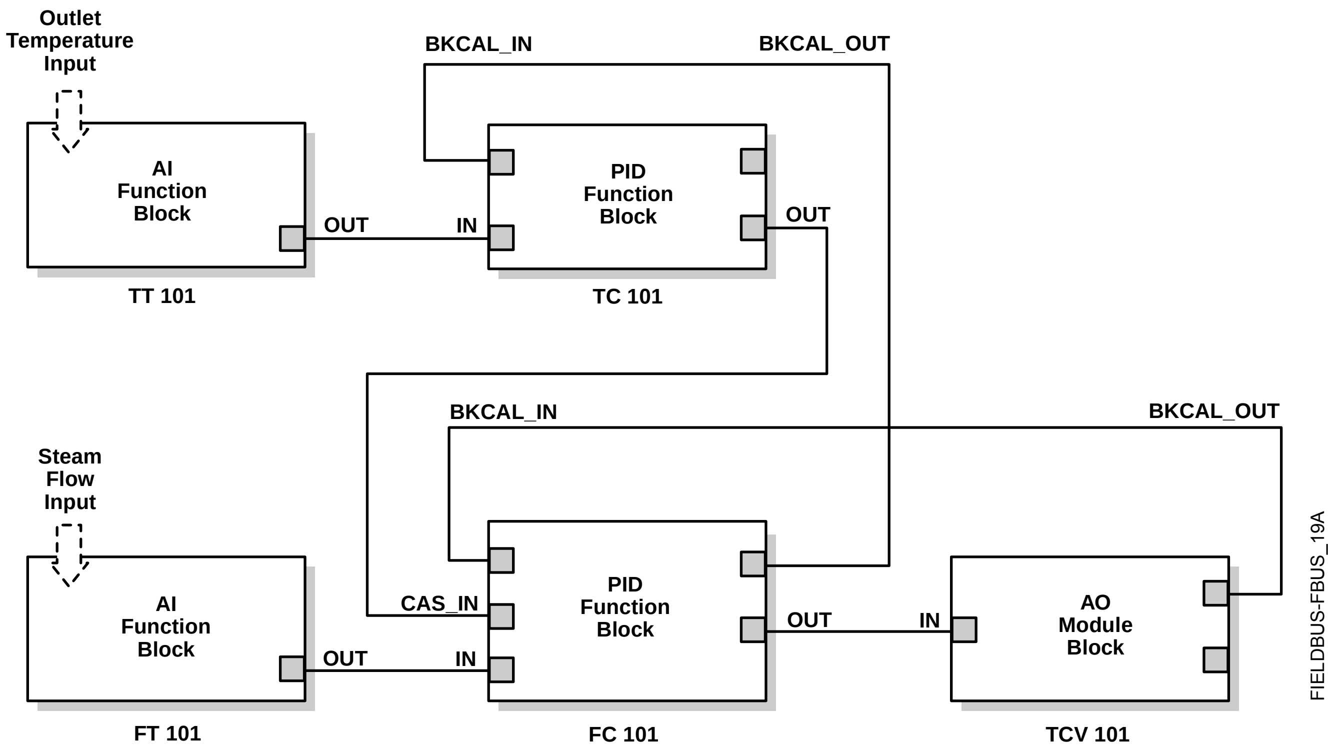
Figure C-7. PID Function Block Cascade Control Example.



Solution

If the flow is controlled, steam pressure variations will be compensated before they significantly affect the heat exchanger temperature. The output from the master temperature loop is used as the setpoint for the slave steam flow loop. The BKCAL_IN and BKCAL_OUT connections on the PID blocks are used to prevent controller windup on the master loop when the slave loop is in Manual or Automatic mode, or it has reached an output constraint. Figure C-8 illustrates the correct function block configuration.

Figure C-8. PID Function Block Diagram for Cascade Control Example.



Application Example: Cascade Control with Override

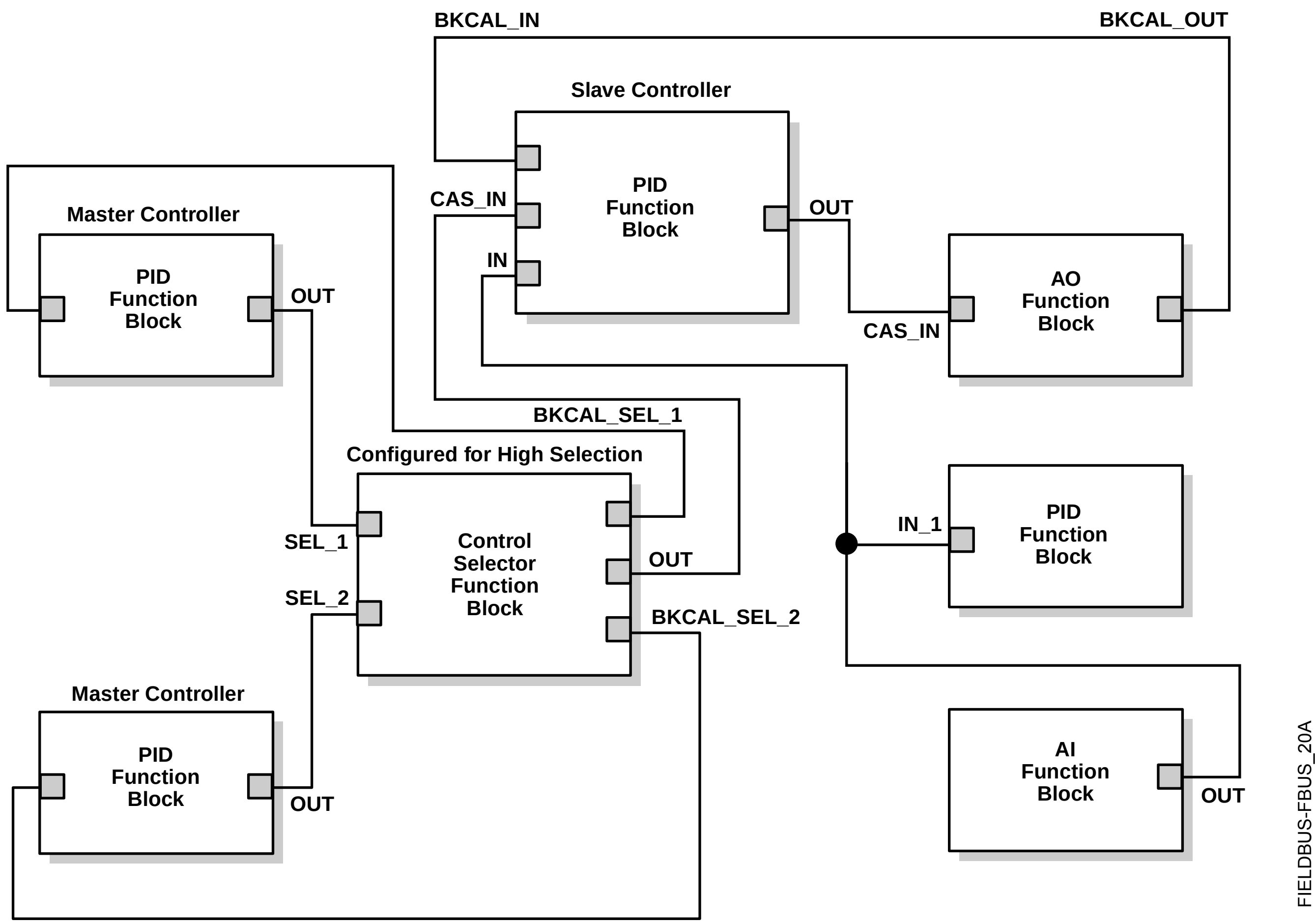
You can use the PID function block with other function blocks for complex control strategies. Figure C-9 illustrates the function block diagram for cascade control with override.

When configured for cascade control with override, if one of the PID function blocks connected to the selector inputs is deselected, that PID block filters the integral value to the selected value (the value at its BKCAL_IN). The selected PID block behaves normally and the deselected controller never winds up. At steady state, the deselected PID block offsets its OUT value from the selected value by the proportional term. When the selected block becomes output-limited, it prevents the integral term from winding further into the limited region.

When the cascade between the slave PID block and the Control Selector block is open, the open cascade status is passed to the Control Selector block and through to the PID blocks supplying input to it. The Control Selector block and the upstream (master) PID blocks have an actual mode of **IMan**.

If the instrument connected to the AI block fails, you can place the AI block in **Manual** mode and set the output to some nominal value for use in the Integrator function block. In this case, IN at the slave PID block is constant and prevents the integral term from increasing or decreasing.

Figure C-9. Function Block Diagram for Cascade Control with Override.



Troubleshooting

Refer to Table C-3 to troubleshoot any problems that you encounter.

TABLE C-3. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	Target mode not set.	Set target mode to something other than OOS.
	Configuration error	BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: • BYPASS must be off or on and cannot be left at initial value of 0. • OUT_HI_LIM must be less than or equal to OUT_LO_LIM. • SP_HI_LIM must be less than or equal to SP_LO_LIM.
	Resource block	The actual mode of the Resource block is OOS. See Resource Block Diagnostics for corrective action.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Mode will not leave IMAN	Back Calculation	BKCAL_IN • The link is not configured (the status would show “Not Connected”). Configure the BKCAL_IN link to the downstream block. • The downstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate downstream block diagnostics for corrective action.
Mode will not change to AUTO	Target mode not set.	Set target mode to something other than OOS.
	Input	IN • The link is not configured (the status would show “Not Connected”). Configure the IN link to the block. • The upstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate upstream block diagnostics for corrective action.
Mode will not change to CAS	Target mode not set.	Set target mode to something other than OOS.
	Cascade input	1. CAS_IN • The link is not configured (the status would show “Not Connected”). Configure the CAS_IN link to the block. • The upstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate up stream block diagnostics for corrective action.

TABLE C-3. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode sheds from RCAS to AUTO	Remote Cascade Value	Host system is not writing RCAS_IN with a quality and status of “good cascade” within shed time (see 2 below).
	Shed Timer	The mode shed timer, SHED_RCAS in the resource block is set too low. Increase the value.
Mode sheds from ROUT to MAN	Remote output value	Host system is not writing ROUT_IN with a quality and status of “good cascade” within shed time (see 2 below).
	Shed timer	The mode shed timer, SHED_RCAS, in the resource block is set too low. Increase the value.
Process and/or block alarms will not work.	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status Options	STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.

Appendix D

Operation with Fisher-Rosemount® DeltaV™

INTRODUCTION

Appendix D provides specific instructions for performing basic configuration operations on the Model 8800C Vortex Flowmeter using the Fisher-Rosemount DeltaV host software. Appendix D is not a comprehensive resource, but a starting point. For more information, refer to the following sources:

- Section 3: Flowmeter Operation for complete information about the transmitter operation that does not depend upon the host software.
- Section 4: Transducer Block for complete information about the transducer block and its parameters.
- Section 5: Resource Block for complete information about the resource block and its parameters.
- Appendix A: FOUNDATION fieldbus Technology and Fieldbus Function Blocks for general information about FOUNDATION fieldbus.
- Appendix B: Analog Input (AI) Function Block for complete information about the AI block and its parameters.
- Appendix C: PID Function Bock for complete information about the PID block and its parameters.
- DeltaV (or your host software title) On-line Help or Documentation for complete information about navigating in the host software that you are using (supplied by the software manufacturer).

SOFTWARE FUNCTIONALITY

The Model 8800C Vortex Flowmeter with FOUNDATION fieldbus software is designed to permit remote testing and configuration using the Fisher-Rosemount DeltaV Fieldbus configuration tool or another FOUNDATION fieldbus host.

CONFIGURE THE LOOP

To completely configure the transmitter for use in a fieldbus loop, you must perform the following procedure:

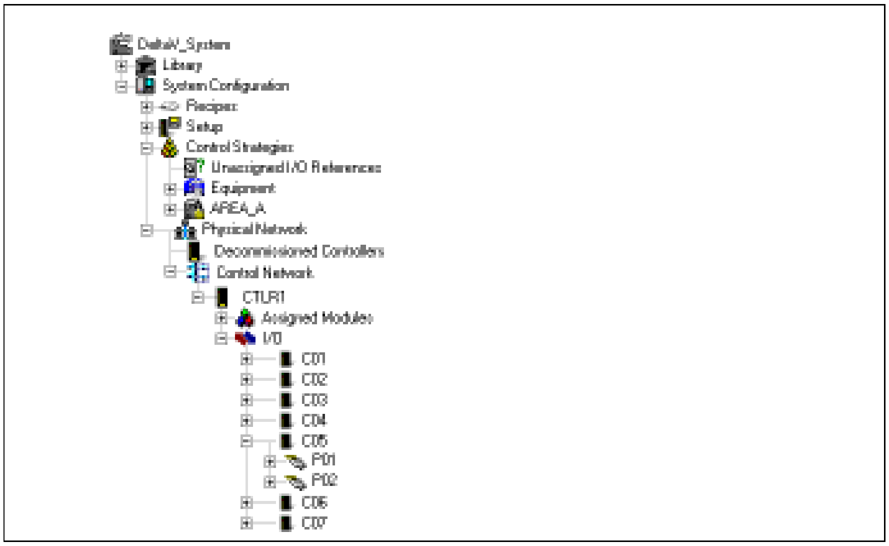
1. *Create a device profile*—A device profile is an electronic representation of the transmitter that exists only in the DeltaV software. The profile is like a place holder for a certain type of transmitter.
2. *Define a control strategy*—The control strategy is the relationship between all of the function blocks on the fieldbus segment.
3. *Commission the device*—Commissioning the device involves copying all applicable parameters from the device profile to the physical device.
4. *Set transmitter configuration parameters*—Set the transmitter configuration parameters to configure the device for use in your specific application.
5. *Download the control strategy to the device*—Download the control strategy to the device to transfer the control strategy from the DeltaV software to the transmitter, where it governs the relationship and operation of all function blocks.

NOTE
The following procedures assume that the DeltaV tool and the transmitter are installed and powered.

Create a Device Profile

1. Click **START** and select **DELTAV > ENGINEERING > DELTAV EXPLORER** from the menus that appear.
2. Navigate through the file structure to the listing of fieldbus ports (see Figure D-1).

Figure D-1. Location of Fieldbus Ports.



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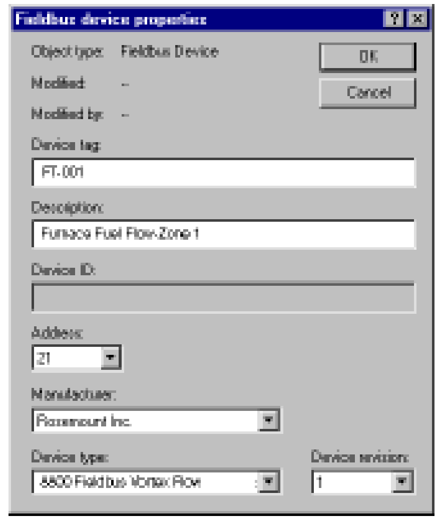
3. Right-click the port to which you wish to connect the new fieldbus device. Select **NEW FIELDBUS DEVICE** from the menu that appears.

The **FIELDBUS DEVICE PROPERTIES** dialog box appears (see Figure D-2).

Figure D-2. **FIELDBUS DEVICE PROPERTIES** Dialog Box.



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4. Enter all of the requested device information in the dialog box.

NOTE
The DeltaV software automatically completes the **ADDRESS** field. You can customize these fields, but it usually is not necessary. Select the device revision based upon the transmitters to be used.

5. Click **OK** to add the device to the segment.

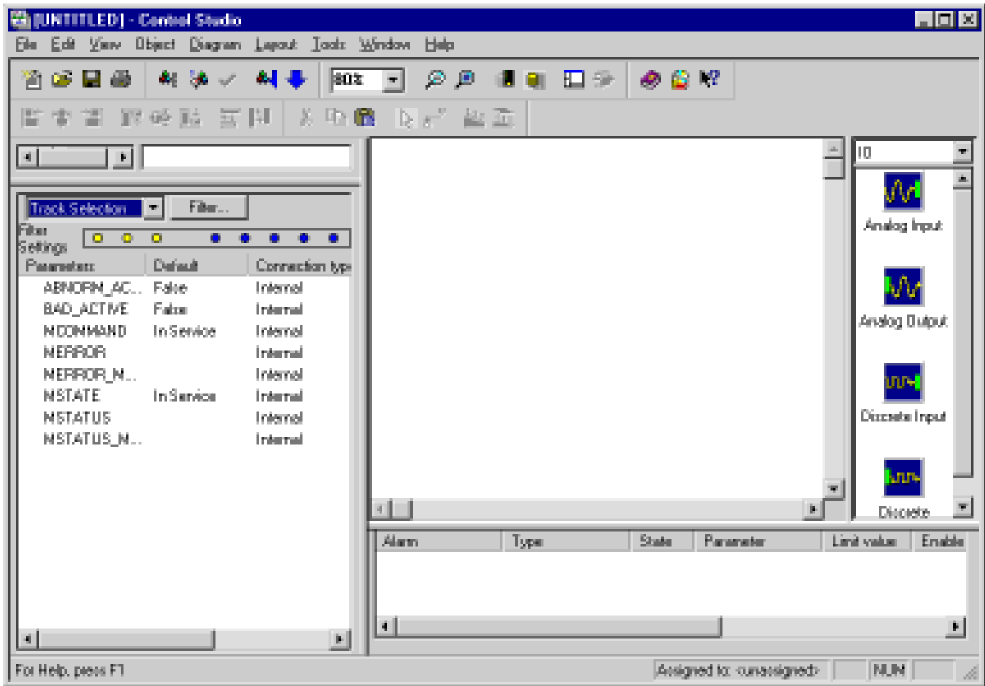
The device appears on the segment as a noncommissioned fieldbus device (FT-001).

Define the Control Strategy

1. Click **START** and select **DELTAV > ENGINEERING > CONTROL STUDIO** from the menus that appear.

The **MAIN CONTROL STUDIO** screen appears (see Figure D-3).

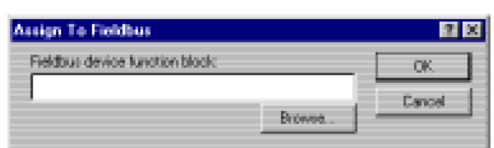
Figure D-3. **MAIN CONTROL STUDIO** Screen.



2. Select the function blocks you wish to add from the menu along the right side of the screen. For the purpose of this example, we will add an AI, a PID, and an AO block.
3. Right-click each block and select **RENAME** from the menu that appears to rename the block with an appropriate tag.
4. Right-click each block and select **ASSIGN I/O > TO FIELDBUS...** to assign the I/O.

The **ASSIGN TO FIELDBUS** dialog box appears (see Figure D-4).

Figure D-4. **ASSIGN TO FIELDBUS** Dialog Box.



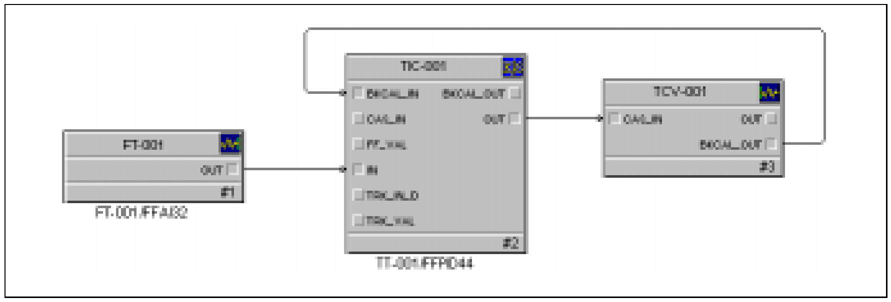
5. Click **BROWSE** to select the device to which you wish to assign each block.

You will have to navigate through the correct controller, I/O, card, and port to reach the device.

6. Connect the blocks as you want them to execute. For the purpose of this example, we connected the blocks as in Figure D-5.

NOTE
If you are not able to draw connections between the blocks (as in Figure D-5), select the **CONNECT** button ( ) and try again.

Figure D-5. Basic Control Strategy.



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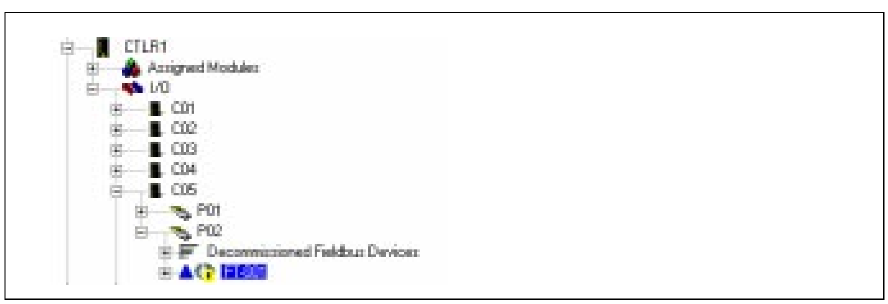
7. Save the control strategy.
8. Click the **ASSIGN TO NODE** button ( ) to assign the strategy to the correct node in the controller.

Commission the Transmitter

To commission the transmitter, drag the appropriate device from the **DECOMMISSIONED FIELDBUS DEVICE** folder to the appropriate device profile.

1. Click **START** and select **DELTAV > ENGINEERING > DELTAV EXPLORER** from the menus that appear.
2. Select the device you wish to commission from the **DECOMMISSIONED FIELDBUS DEVICES** folder. The device will be listed under its unique serial number (001151 DVT90031153103013).
3. Drag the decommissioned device to the device profile that you created earlier (see Figure D-6).

Figure D-6. Sample Location of a Transmitter Profile in DeltaV Explorer.



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The **DEVICE COMMISSIONING WIZARD – START** dialog box appears (see Figure D-7).

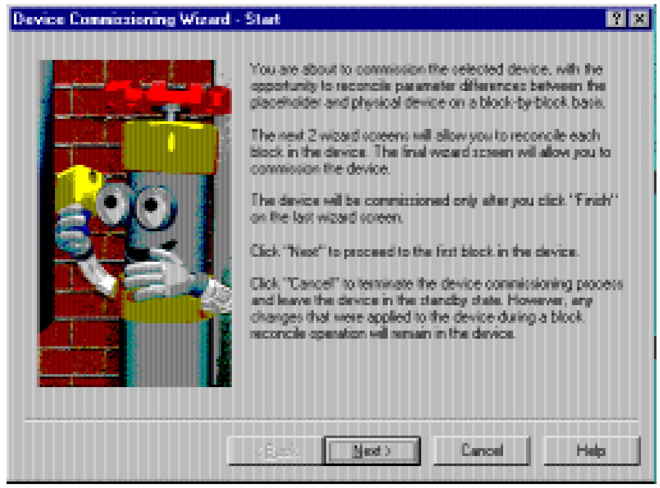

Figure D-7. **DEVICE COMMISSIONING WIZARD – START** Dialog Box.

4. Click **NEXT**.

The **DEVICE COMMISSIONING WIZARD – RECONCILE BLOCK** dialog box 1 appears (see Figure D-8).

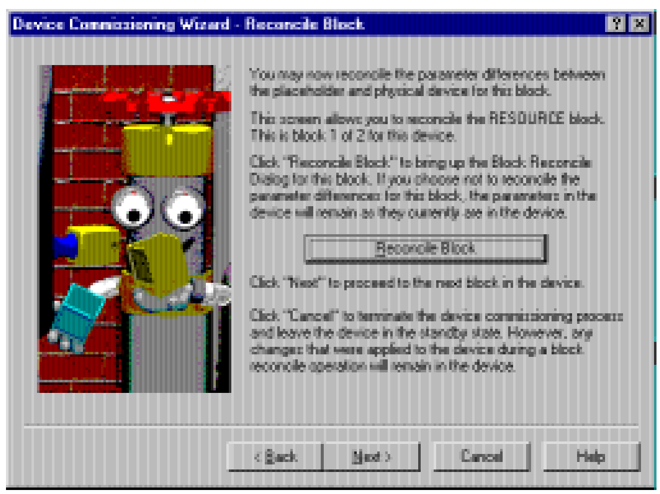

Figure D-8. **DEVICE COMMISSIONING WIZARD – RECONCILE BLOCK** Dialog Box 1.

NOTE
To reconcile differences between the resource block in the transmitter and the resource block in the device profile that you created, click **RECONCILE BLOCK**. To override the settings in the device profile with the settings in the device, go to Step 5.

5. Click **NEXT**.

The **DEVICE COMMISSIONING WIZARD – RECONCILE BLOCK** dialog box 2 appears (see Figure D-9).

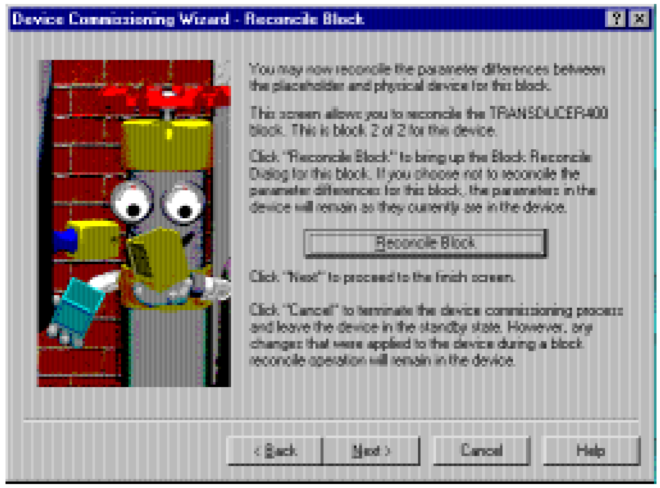

Figure D-9. **DEVICE COMMISSIONING WIZARD – RECONCILE BLOCK** Dialog Box 2.

NOTE
To reconcile differences between the transducer block in the transmitter and the transducer block in the device profile that you created, click **RECONCILE BLOCK**. To override the settings in the device profile with the settings in the device, go to Step 6.

6. Click **NEXT**.

The **DEVICE COMMISSIONING WIZARD – FINISH** dialog box appears (see Figure D-10).

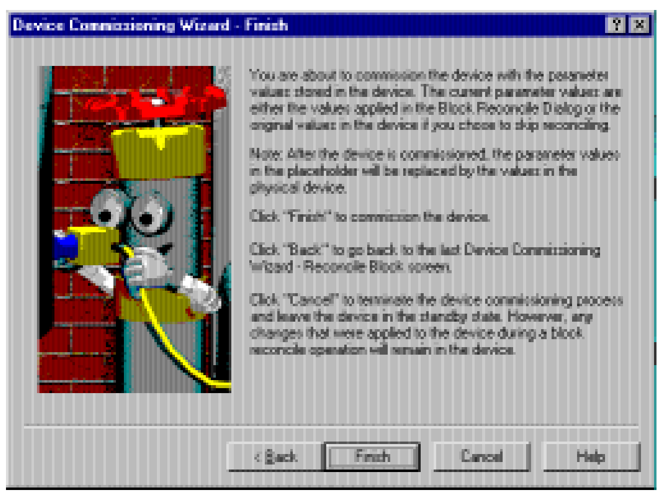

Figure D-10. **DEVICE COMMISSIONING WIZARD – FINISH** Dialog Box.

7. Click **FINISH**.

A dialog box appears informing you that the DeltaV software is waiting for the device to change from a decommissioned to a commissioned state (see Figure D-11). The process may take several minutes.

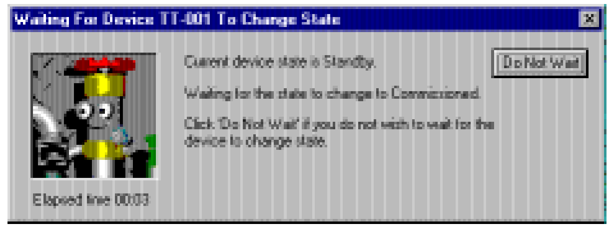

Figure D-11. **WAITING FOR DEVICE TO CHANGE STATE** Dialog Box.

Once the DeltaV software finishes commissioning the device, the icon in **DELTAV EXPLORER** changes from noncommissioned (FT-001) to commissioned (FT-001).

Set Transmitter Configuration Parameters

1. Click **START** and select **DELTAV > ENGINEERING > DELTAV EXPLORER** from the menus that appear.
2. Navigate through the file structure to find the transmitter you wish to configure (see Figure D-12).

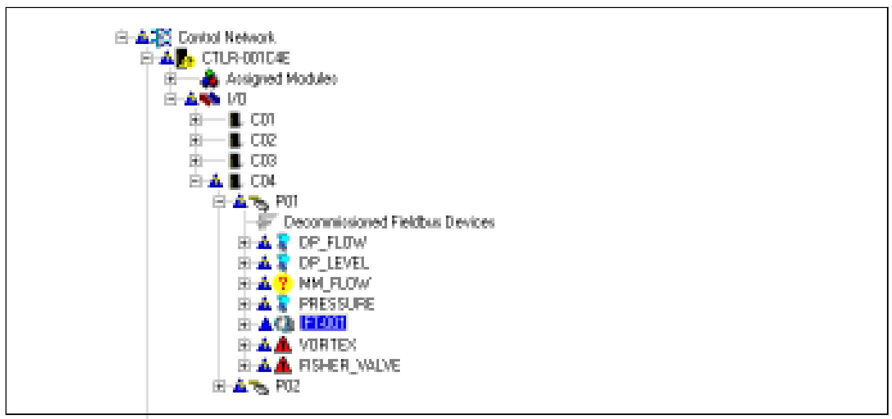

Figure D-12. Sample Location of a Transmitter in DeltaV Explorer.

3. Double-click the transmitter you wish to configure.

The function blocks within the transmitter appear in the right half of the **DELTA V EXPLORER** dialog box (see Figure D-13).

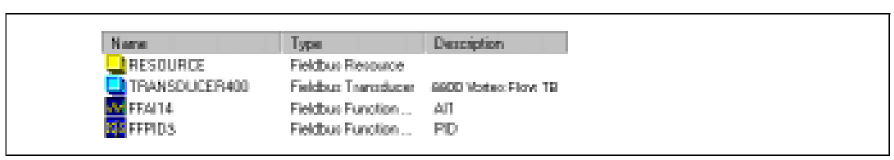

Figure D-13. List of Function Blocks in DeltaV Explorer.

4. Double-click the **TRANSDUCER BLOCK** icon.

The **TRANSDUCER BLOCK PROPERTIES** dialog box appears (see Figure D-14).

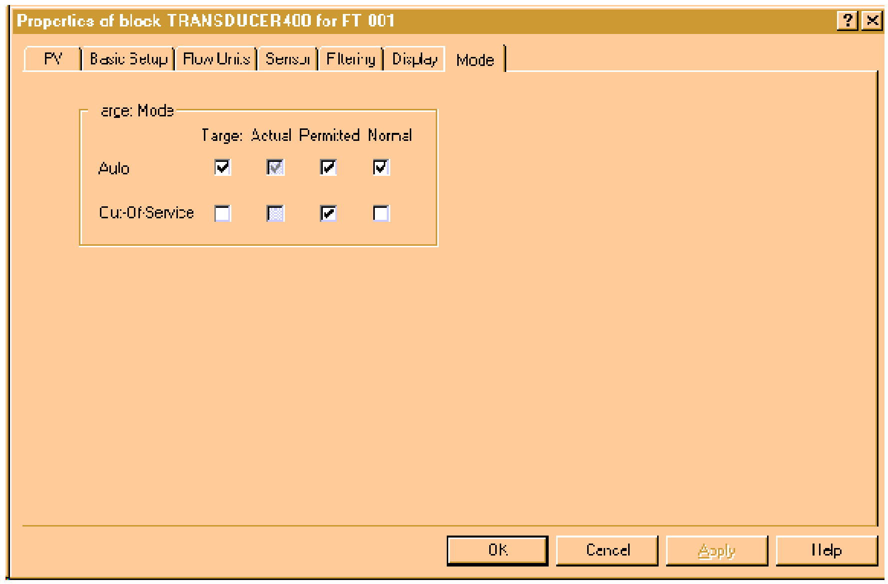

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Figure D-14. **TRANSDUCER BLOCK PROPERTIES** Dialog Box.

5. Click the **MODE** tab.
6. Select the **OUT OF SERVICE** (OOS) check box and deselect the **AUTO** check box in the **TARGET MODE** column of the dialog box.

The parameters you change in the **TRANSDUCER BLOCK PROPERTIES** dialog box remain highlighted (as in Figure D-14) so you can easily track changes.

7. Click **APPLY** to apply the changes you made.

NOTE
The software warns you that the changes you made may upset the process and create a dangerous situation in your plant (see Figure D-15). Verify that the control loop is in manual control before proceeding.

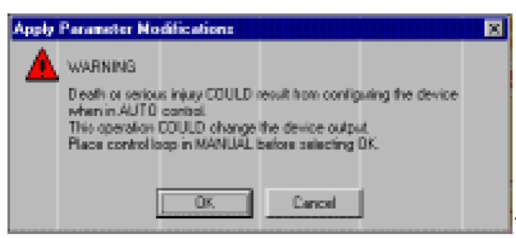


Figure D-15. **TRANSDUCER BLOCK PROPERTIES** Dialog Box.

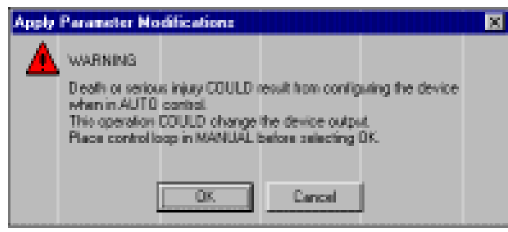
8. Click **OK**.

The **ACTUAL MODE** region changes to **OOS**.

9. Click **OK** to return to the **DELTA V EXPLORER**.
10. Right-click on the **TRANSDUCER** block icon to access the **CONFIGURATION PARAMETERS** menu.
11. Select the parameter you wish to configure, and follow the on-line instructions to complete the configuration.

NOTE
As you make changes to the configuration parameters, the software warns you that the changes you made may upset the process and create a dangerous situation in your plant (see Figure D-16). Verify that the control loop is in manual control before proceeding.

Figure D-16. **TRANSDUCER BLOCK PROPERTIES** Dialog Box.



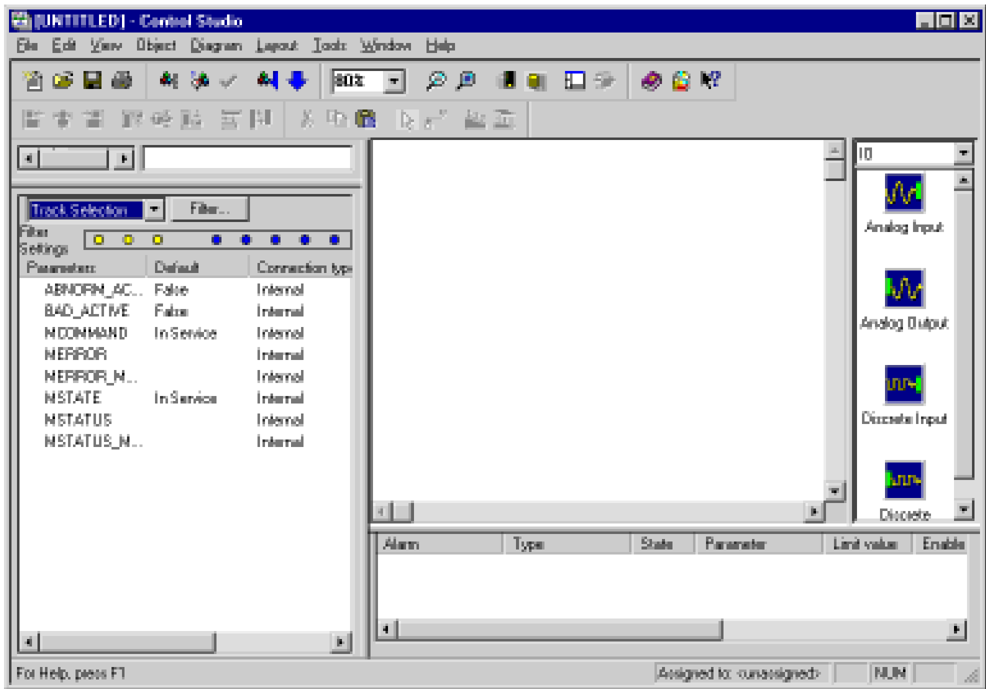
12. Repeat Steps 4 through 8 to return the mode of the transducer block to **Auto**.

Download the Control Strategy to the Device

1. Click **START** and select **DELTAV > ENGINEERING > CONTROL STUDIO** from the menus that appear.

The **MAIN CONTROL STUDIO** screen appears (see Figure D-17).

Figure D-17. **MAIN CONTROL STUDIO** Screen.



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2. Open the control strategy that you defined on Pages G-4 and G-5.
3. Click the **DOWNLOAD** button () and follow the on-line instructions to download the control strategy to the transmitter.

Appendix **E**

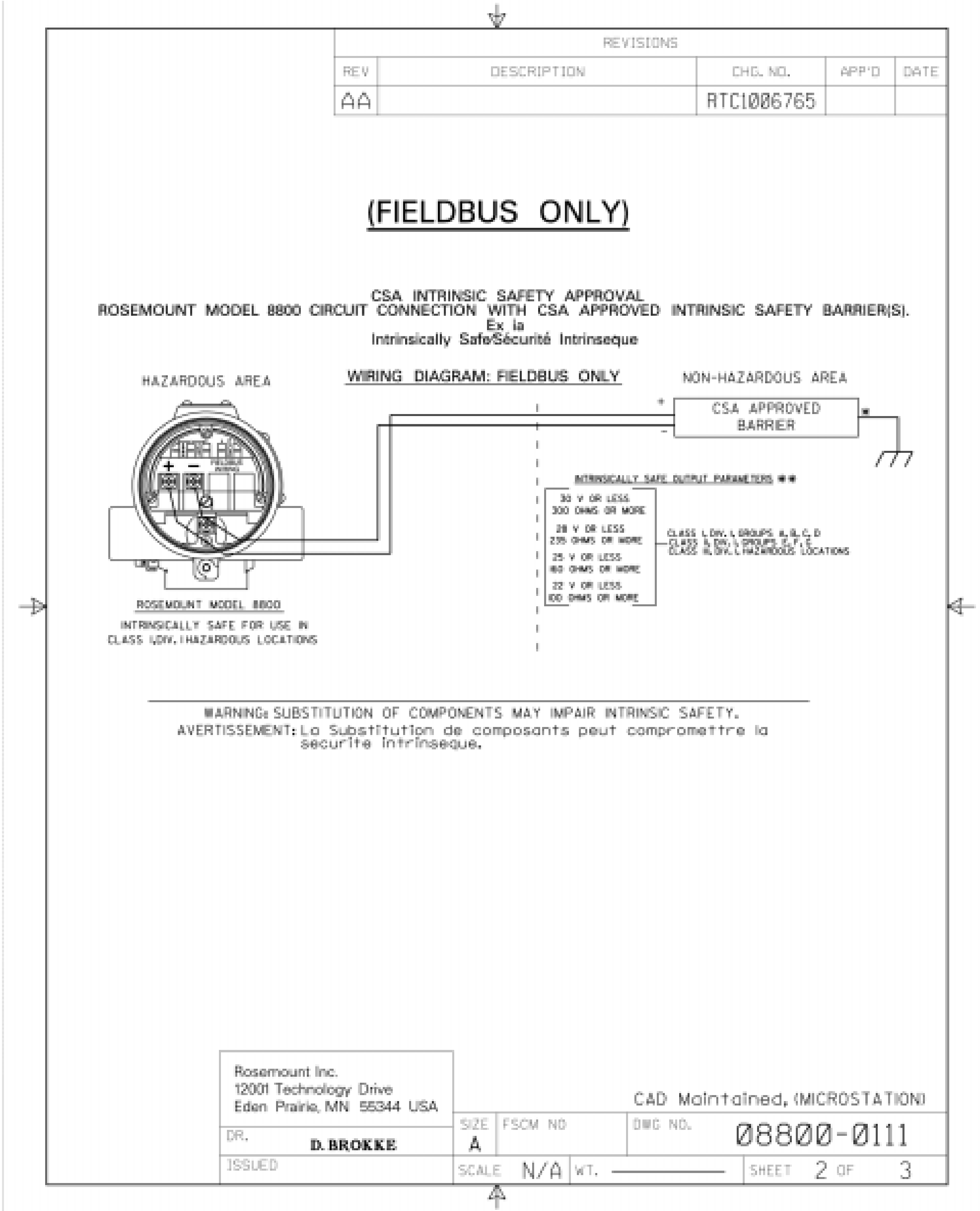
Approval Drawings

CSA Intrinsic Safety Installation Drawings

Rosemount Drawing 08800-0111, Rev. AA, 2 Sheets:
CSA Intrinsic Safety Installation Drawings for Model 8800C.

FM Intrinsic Safety Installation Drawings

Rosemount Drawing 08800-0106, Rev. AA, 2 Sheets:
Factory Mutual Intrinsic Safety Installation Drawings for Model 8800C.


REVISIONS
REV
DESCRIPTION
CHG. NO.
APP'D
DATE
AA
RTC1006765
(FIELDBUS ONLY)
CSA INTRINSIC SAFETY APPROVAL
ROSEMOUNT MODEL 8800 CIRCUIT CONNECTION WITH CSA APPROVED INTRINSIC SAFETY BARRIER(S).
Ex ia
Intrinsically Safe/Sécurité Intrinseque
HAZARDOUS AREA
WIRING DIAGRAM: FIELDBUS ONLY
NON-HAZARDOUS AREA
CSA APPROVED BARRIER
INTRINSICALLY SAFE OUTPUT PARAMETERS
30 V OR LESS
300 OHMS OR MORE
28 V OR LESS
235 OHMS OR MORE
25 V OR LESS
160 OHMS OR MORE
22 V OR LESS
100 OHMS OR MORE
CLASS I, DIV. I, GROUPS A, B, C, D
ROSEMOUNT MODEL 8800
INTRINSICALLY SAFE FOR USE IN
CLASS I, DIV. I HAZARDOUS LOCATIONS
WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.
AVERTISSEMENT: La Substitution de composants peut compromettre la securite intrinseque.
Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 USA
CAD Maintained, (MICROSTATION)
DR.
D. BROKKE
SIZE
A
FSCM NO
DWG NO.
08800-0111
ISSUED
SCALE
N/A
WT.
SHEET 2 OF 3

8800-0111AA

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1006765		

* ALL LINES CONNECTED TO THE MODEL 8800 MUST BE TERMINATED BY EITHER A CSA APPROVED BARRIER OR AN I.S. SAFETY GROUND.

** WHEN USING MORE THAN ONE CHANNEL OF A CSA APPROVED BARRIER, THE EFFECTIVE VOLTAGE AND RESISTANCE OF THE COMBINED LINES MUST COMPLY WITH THE LISTED INTRINSICALLY SAFE OUTPUT PARAMETERS. THE EFFECTIVE VOLTAGE AND RESISTANCE ARE TO BE CALCULATED AS FOLLOWS:

VOLTAGE: EFFECTIVE VOLTAGE = HIGHEST BARRIER VOLTAGE
(NOTE: BOTH LINES MUST BE REFERENCED TO A COMMON GROUND)

RESISTANCE: EFFECTIVE RESISTANCE = PARALLEL COMBINATION OF EACH LINE
(NOTE: DIODE RETURNS DO NOT NEED TO BE INCLUDED FOR THIS CALCULATION)

<u>EXAMPLE #1:</u> BARRIER 1: VOLTAGE = 28V; RESISTANCE = 330 OHMS
BARRIER 2: VOLTAGE = 28V; RESISTANCE = 330 OHMS
EFFECTIVE VOLTAGE = 28V
EFFECTIVE RESISTANCE = $\frac{R_1 R_2}{R_1 + R_2}$ = 165 OHMS

<u>RESULT:</u> THIS BARRIER COMBINATION WOULD BE ACCEPTABLE FOR GROUPS C, D SINCE THE EFFECTIVE VOLTAGE IS LESS THAN OR EQUAL TO 30V AND THE EFFECTIVE RESISTANCE IS GREATER THAN OR EQUAL TO 150 OHMS.

<u>EXAMPLE #2:</u> BARRIER 1: VOLTAGE = 28V; RESISTANCE = 330 OHMS (4-20 "+")
BARRIER 2: 28V DIODE RETURN (4-20 "-")
BARRIER 3: VOLTAGE = 28V; RESISTANCE = 1000 OHMS (PULSE "+")
BARRIER 4: 28V DIODE RETURN (PULSE "-")
EFFECTIVE VOLTAGE = 28V
EFFECTIVE RESISTANCE = $\frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}}$ = 248 OHMS

<u>RESULT:</u> THIS BARRIER COMBINATION WOULD BE ACCEPTABLE FOR GROUPS C, D SINCE THE EFFECTIVE VOLTAGE IS LESS THAN OR EQUAL TO 30V AND THE EFFECTIVE RESISTANCE IS GREATER THAN OR EQUAL TO 150 OHMS.

Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 USA

CAD Maintained, (MICROSTATION)

DR. D. BROKKE	SIZE A	FSCM NO	DWG NO. 08800-0111
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 3

8800-011AA03

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1007317		

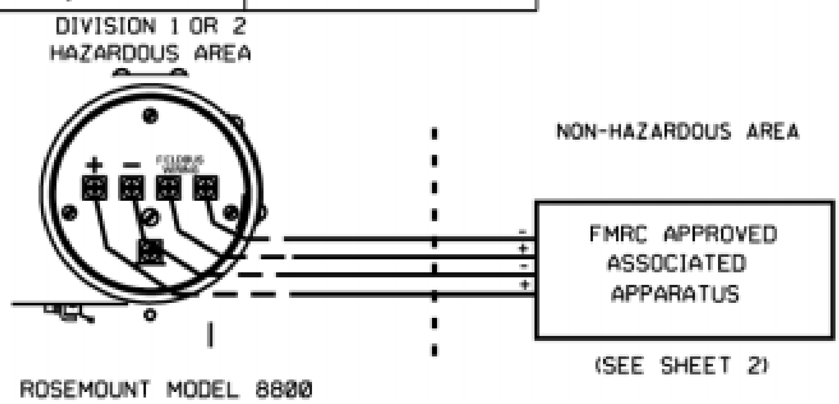
(FIELDBUS ONLY)
FMRC INTRINSIC SAFETY APPROVAL

THE ROSEMOUNT MODEL 8800 SMART VORTEX FLOWMETER IS FMRC APPROVED AS INTRINSICALLY SAFE WHEN INSTALLED PER THE NATIONAL ELECTRIC CODE (NEC) ARTICLE 504 WITH FMRC APPROVED ASSOCIATED APPARATUS WHICH MEETS THE ENTITY PARAMETERS INDICATED BELOW. ADDITIONALLY, THE ROSEMOUNT MODEL 751 FIELD SIGNAL INDICATOR IS FMRC APPROVED AS INTRISICALLY SAFE WHEN CONNECTED IN CIRCUIT WITH THE ROSEMOUNT MODEL 8800 AS SPECIFIED IN THIS DRAWING.

INTRINSICALLY SAFE FOR CLASS I, DIV. 1, GROUPS A, B, C, D; CLASS II, DIV. 1, GROUPS E, F, G; CLASS III, DIV. 1 HAZARDOUS LOCATIONS.

TERMINALS "+", "-"	ASSOCIATED APPARATUS PARAMETERS
V_{max} = 30Vdc I_{max} = 300mA P_{max} = 1.3W C_i = 0μF L_i = 20μH	V_{oc} OR $V_t \leq$ 30V I_{sc} OR $I_t \leq$ 300mA C_a > C_{cable} + C_i L_a > L_{cable} + L_i

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUTS



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12001 Technology Drive
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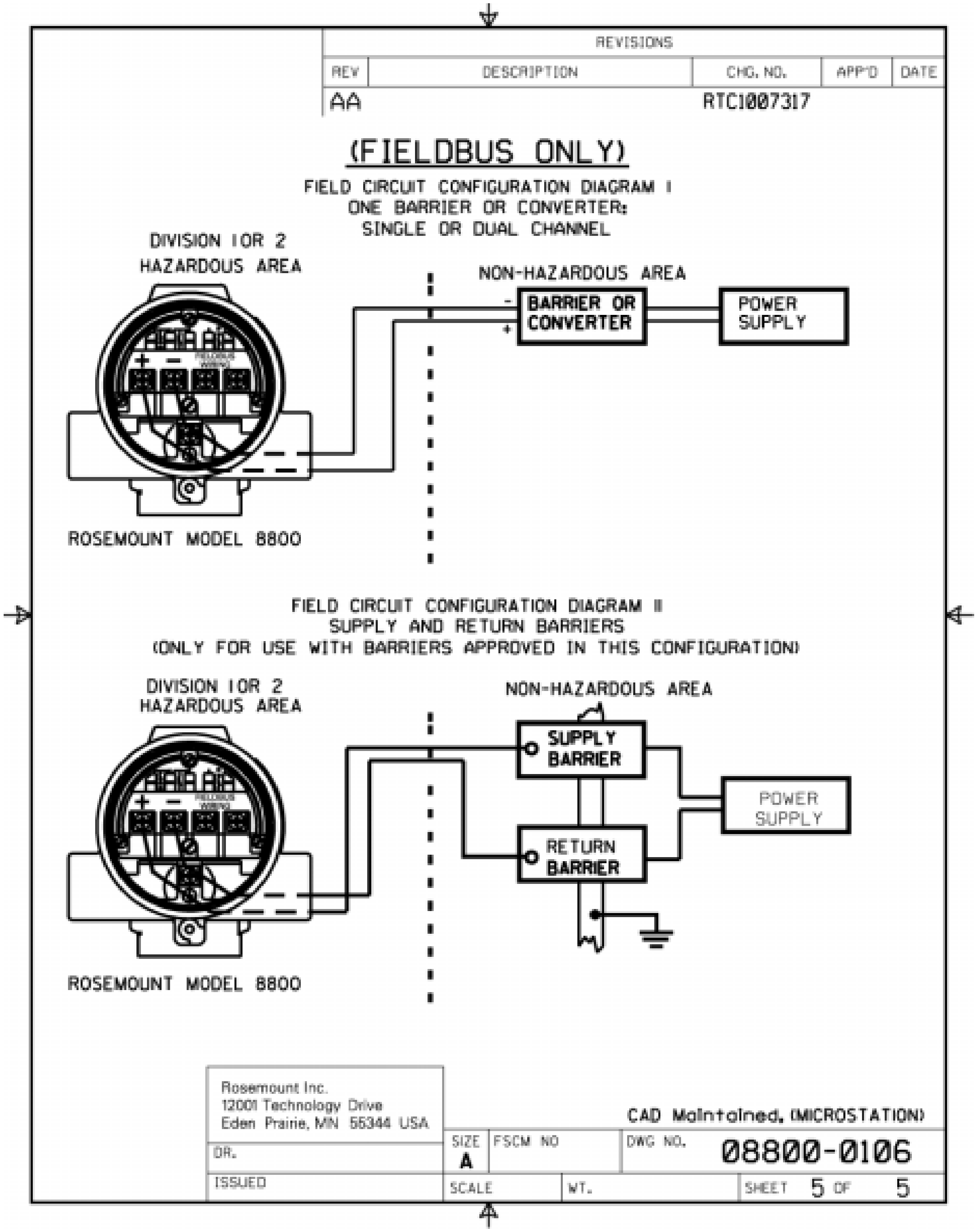
8800-0111AA05



8800-0111AA04

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Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA
Tel 1-800-999-9307
Fax (612) 949-7001

PRINTED IN USA

http://www.rosemount.com

Fisher-Rosemount Flow
Groeneveldselaan 6-8
3903 AZ Veenendaal
The Netherlands
Tel 31 (0) 318 549 549
Fax 31 (0) 318 549 559
Tel 0800-966 180 (U.K. only)
Fax 0800-966 181 (U.K. only)

00809-0100-4772 Rev. DA 1/00

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